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FUEL SYSTEM

INTRODUCTION

Marea and Marea Weekend 1.9 JTD cars are equipped with a 4 cylinder in line, 1910 cc turbodiesel engine with two valves per cylinder, an overhead camshaft, turbocharger and intercooler and electronic injection.

The fuel system ensures correct engine operation and can be divided into the following subsystems:

- Fuel feed circuit with common rail injection;
- air feed circuit;
- exhaust circuit;
- blow by vapour recirculation circuit;
- Exhaust Gas Recirculation (EGR) circuit

Operation of the various circuits making up the fuel system is optimised by an electronic control system managed by a special control unit.

The main feature of the fuel system is common rail fuel injection. Common rail is a higher pressure electronic injection system for fast direct injection diesel engines.

The main features of the common rail system are as follows:

- availability of high injection pressures (up to 1350 bars);
- possibility of modulating these pressures (from a minimum of 150 bars to a maximum of 1350 bars) independently of engine speed (rpm) and engine load;
- ability to operate at high engine speeds (up to 6000 rpm);
- precise injection control (injection advance and duration);
- reduced fuel consumption;
- reduced emissions.

FUEL SYSTEM MANAGEMENT STRATEGIES

The management program (software) is stored inside the control unit memory and consists of a series of strategies, each of which manages a precise system control function.

Through the use of information provided by the various sensors (input), each strategy processes a set of parameters based on data stored in special control unit memory areas. It then controls system actuators (output), i.e. the devices that allow the engine to operate.

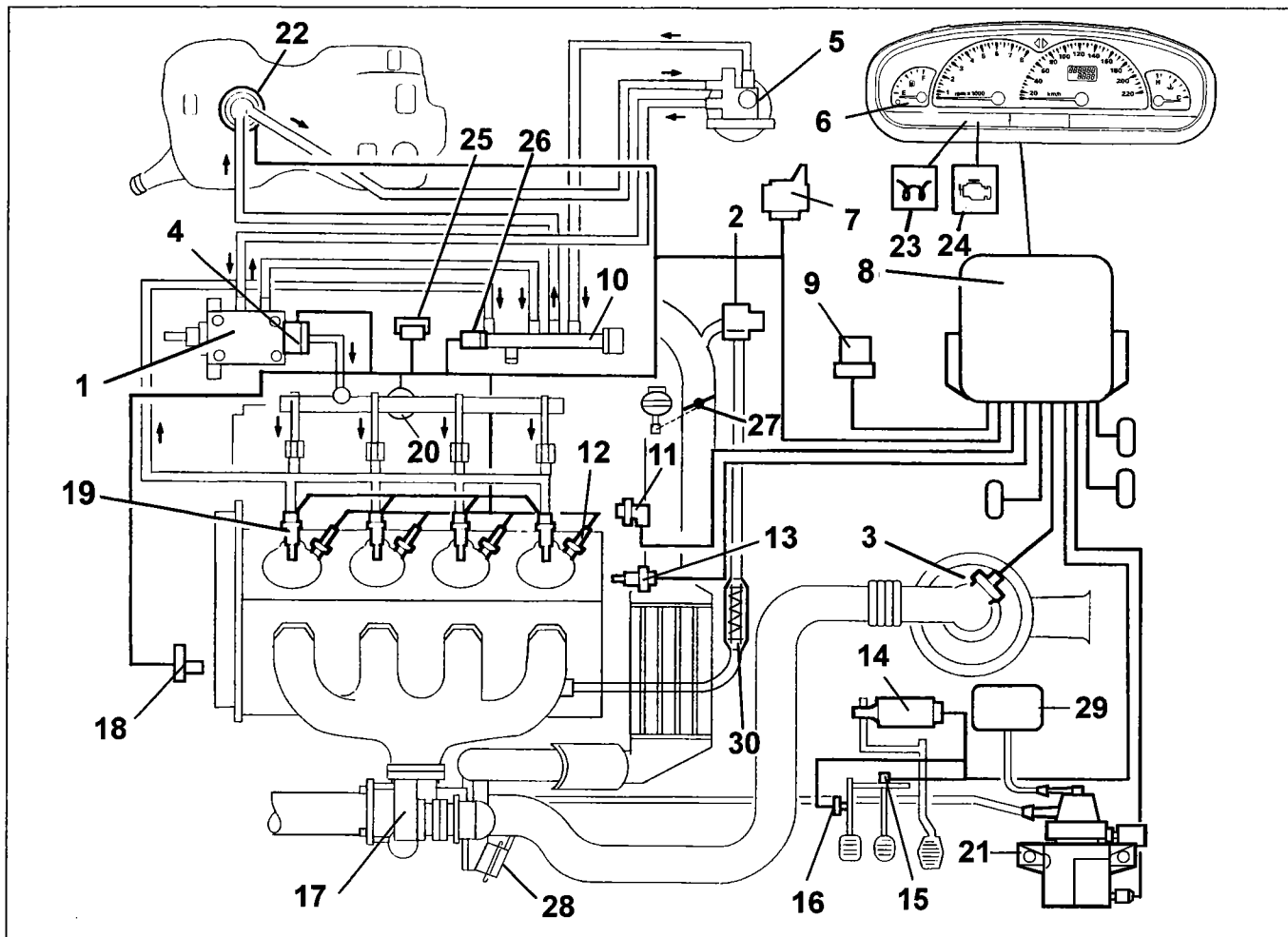
The main purpose of these management strategies is to determine the exact amount of fuel to be injected into the cylinders with timing (injection advance) and pressure designed to achieve the best possible engine performance in terms of power, fuel consumption, fumes, emissions and handling.

The main system management strategies are essentially as follows:

- control of injected fuel quantity;
- control of injection advance;
- control of injection pressure;
- control of auxiliary fuel pump;
- control of injection during over-run (cut-off);
- control of idle speed;
- control of maximum speed limitation;
- control of maximum torque limitation;
- control of fuel temperature;
- control of engine coolant temperature;
- control of air turbocharging pressure;
- control of glow plugs;
- control of exhaust fumes;
- control of exhaust gas recirculation (EGR);
- control of climate control system activation;
- control of engine immobiliser operation (Fiat CODE);
- self-diagnosis

10.

FUEL SYSTEM OPERATING DIAGRAM



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- | | |
|---|--|
| 1. Pressure pump | 23. Glow plug preheating warning light |
| 2. Electrically-controlled EGR valve | 24. System failure warning light |
| 3. Flow meter | 25. Pressure relief sensor |
| 4. Pressure regulator | 26. Fuel temperature sensor |
| 5. Fuel filter | 27. Throttle valve |
| 6. Instrument panel | 28. Variable geometry actuator |
| 7. Glow plug preheating control unit | 29. Vacuum tank |
| 8. Electronic control unit | 30. Exhaust gas heat exchanger |
| 9. Injection system relay | |
| 10. Return manifold (low pressure) | |
| 11. RPM sensor | |
| 12. Glow plugs | |
| 13. Engine coolant temperature sensor | |
| 14. Potentiometer on accelerator pedal | |
| 15. Switch on brake pedal | |
| 16. Switch on clutch pedal | |
| 17. Variable geometry turbocharger | |
| 18. Timing sensor | |
| 19. Injectors | |
| 20. Fuel pressure sensor | |
| 21. Variable geometry turbocharger control solenoid | |
| 22. Auxiliary fuel pump | |

Control of injected fuel quantity

The control unit controls the fuel pressure regulator and injectors on the basis of output signals from the accelerator pedal potentiometer, flow meter and rpm sensor.

The timing and thus the injection sequence are determined when the engine is started up using signals from the rpm and timing sensor (synchronisation stage); injection timing is then implemented using the rpm sensor signal alone and considering a injection sequence of 1-3-4-2.

The control unit inhibits injection in the following cases:

- fuel pressure level greater than 1500 bars;
- fuel pressure level lower than 120 bars;
- engine speed higher than 6000 rpm.

When the engine has warmed up, maximum injection duration (injector opening time) is 1500 ns, but it can reach 3000 ns during the start-up stage.

Control of injection advance

The electronic control unit determines injection advance mainly on the basis of the quantity of fuel to be injected.

The injection advance is then corrected on the basis of coolant temperature and speed in order to compensate for ignition delays due to low temperatures in the combustion chamber during warm-up.

The optimum injection point is also processed to ensure driving comfort and emission limits laid down by Euro 3 legislation.

Control of injection pressure

This control is of particular importance because injection pressure influences the following parameters:

- amount of fuel taken into the cylinders for the same injection time duration;
- injected fuel nebulation;
- spray penetration;
- lag between electrical control to injection and actual injection start and end times.

The above parameters engine behaviour significantly, particularly in terms of power output, exhaust emissions, noise levels and handling.

The injection control unit controls the pressure governor on the basis of engine load to obtain an optimal line pressure at all times.

When the engine is cold, injection pressure is corrected on the basis of engine speed and engine coolant temperature to meet engine needs at different operating temperatures.

Control of auxiliary fuel pump

The auxiliary fuel pump submerged in the tank is supplied by the injection control unit by means of a relay when the ignition key is turned on.

Fuel supply to the pump is inhibited when one of the following condition occurs:

- when the ignition has been turned on for a certain length of time without the engine running;
- if the inertia switch cuts in.

Control of injection during over-run (cut-off)

The fuel cut-off strategy is implemented when the injection control unit receives information that the accelerator pedal has been released from the potentiometer.

Under these conditions, the control unit cuts off the fuel supply to the injectors and restores it before idle speed is reached.

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Control of idle speed

On the basis of signals from the rpm sensor and engine coolant temperature sensor, the injection control unit controls the pressure governor and alters the injector control times to maintain idle speed stable at all times.

Under certain conditions, the idle speed control unit also considers battery voltage.

Control of maximum speed limitation

According to rpm level, the injection control unit limits maximum speed by means of two types of intervention:

- as maximum speed approaches, it reduces the amount of fuel injected to reduce line pressure;
- when maximum speed is exceeded, it inhibits operation of the auxiliary pump and injectors.

Control of maximum torque limitation

On the basis of rpm level, the injection control unit computes limit torque and maximum permitted fume index parameters on the basis of predefined, stored maps.

It then corrects the above parameters using engine coolant temperature and car speed data. The resulting values are then used to modulate the amount of fuel to be injected by adjusting the pressure regulator and injectors.

Control of fuel temperature

The injection control unit is kept constantly informed of fuel temperature by a sensor on the return manifold.

If fuel temperature exceeds a set value (about 110 °C), the control unit reduces line pressure by adjusting the pressure governor, leaving injection times unaltered.

Control of coolant temperature

The injection control unit is constantly informed of coolant temperature by a sensor on the thermostat.

If engine coolant temperature or air conditioning fluid pressure exceeds certain levels, the control unit performs the following actions:

- It reduces the amount of fuel injected by adjusting the pressure governor and injectors (power reduction);
- it controls the engine radiator cooling fan.

Control of glow plugs

The injection control unit controls operation of the glow plug preheating control unit to bring the temperature in the combustion chambers up to levels that promote fuel self-ignition and thus make start-up easier.

The control unit controls the operation of the glow plug control unit for a certain time both before (preheating) and after (postheating) engine start-up and also controls activation of the warning light on the control panel.

Preheating, postheating and glow plug warning light activation times vary according to engine coolant temperature.

Exhaust fumes control

Through this function the injection control unit limits any exhaust fumes that could be produced during transition speeds.

To satisfy these requirements the control unit processes the signals supplied by the accelerator pedal potentiometer, the rpm sensor and the air flow meter and controls the fuel pressure regulator and the injectors to meter the correct amount of fuel to inject.

Exhaust gas recirculation control

On the basis of the signals supplied by the rpm sensor, intake air quantity sensor, engine coolant temperature sensor and accelerator pedal position sensor, the control unit calculates the operating times for the EGR valve so that the exhaust gases are partly recirculated in certain engine operating conditions in line with Euro 3 pollution control standards.

Air conditioning system engagement control

The injection control unit manages the operation of the air conditioning system compressor electromagnet coupling following a logic aimed at preventing operating conditions that would adversely affect engine performance.

- When the compressor is switched on the injection control unit increases the quantity of fuel during idling to allow the engine to adjust to the increased power requirements and momentarily interrupts the supply to the compressor in high engine power requirement conditions (strong acceleration).

Engine immobilizer function control

The system is equipped with an engine immobilizer function. This function is achieved through the presence of a specific control unit (Fiat CODE), capable of conversing with the injection control unit and an electronic key with a special transmitter for sending a recognition code.

Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the injection control unit.

When the key is turned to the ON position the following operations take place, in order:

1. the injection control unit (whose memory contains a secret code) sends the Fiat CODE control unit a request to send the secret code to deactivate the immobilizer functions;
2. the Fiat CODE control unit responds by only sending the secret code after, in turn, having received the recognition code transmitted by the ignition key;
3. the recognition of the secret code allows the deactivation of the injection control unit immobilizer function and its normal operation.

Autodiagnosis

The complete electronic fault diagnosis of the injection system is carried out by connecting the special equipment (EXAMINER or EXAMINER PLUS) to the standardized diagnostic socket (EOBD).

The system is also equipped with a self-diagnostic function which recognizes, memorizes and signals any faults.

If a fault is detected in the sensors or actuators, the recovery strategy is immediately activated in order to ensure that the engine functions at an acceptable level. The vehicle can be driven to a service centre for the appropriate repairs to be carried out.

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The control unit autodiagnostic system checks the signals coming from the sensors and compares them with the figures allowed:

- signalling faults during starting
- warning light on for 4 seconds indicates test stage
- warning light off after 4 seconds indicates no fault with components that could alter the pollution control standard figures
- warning light on after 4 seconds indicates fault.
- signalling faults during operation
- warning light on indicates fault
- warning light off indicates no fault with components that could alter the pollution control standard figures.
- recovery
- from time to time, the control unit defines the type of recovery according to the components which are faulty
- the recovery parameters are managed by components which are not faulty.

Control of cylinder balancing during idling

According to the signals coming from the sensors, the injection control unit controls the idle speed torque, altering the injector operating times.

Control of irregular operation

Depending on the signals coming from the sensors, the injection control unit corrects the amount of fuel to be injected in order to improve driveability and reduce jerking whilst driving.

The correction is achieved through the fuel pressure regulator and by varying the injector operating times.

Control of electrical balance

According to the battery voltage, the injection control unit alters the idle speed, to guarantee a sufficient current supply from the alternator in situations where the consumers are absorbing a great deal of power.

The variation in the idle speed is achieved by regulating the fuel pressure and altering the injector operating times.

VGT variable geometry turbocharger control (1910 JTD 110 CV)

The injection control unit processes the signal coming from the supercharging sensor, at the various engine operating speeds, and determines the quantity of fuel to be injected, acting on the fuel pressure regulator and the injector opening times.

In addition, through the solenoid valve, the control unit regulates the geometry of the turbine in order to ensure optimum performance in all operating conditions.

Turbocharger waste gate valve control (1910 JTD 100 CV)

At the various engine operating speeds, the injection control unit processes the signal coming from the supercharging sensor and determines the amount of fuel to inject, acting on the fuel pressure regulator and the injector opening times.

In addition, the control unit controls the opening of the turbocharger waste gate valve, via the solenoid valve, in order to ensure excellent performance in all operating conditions.

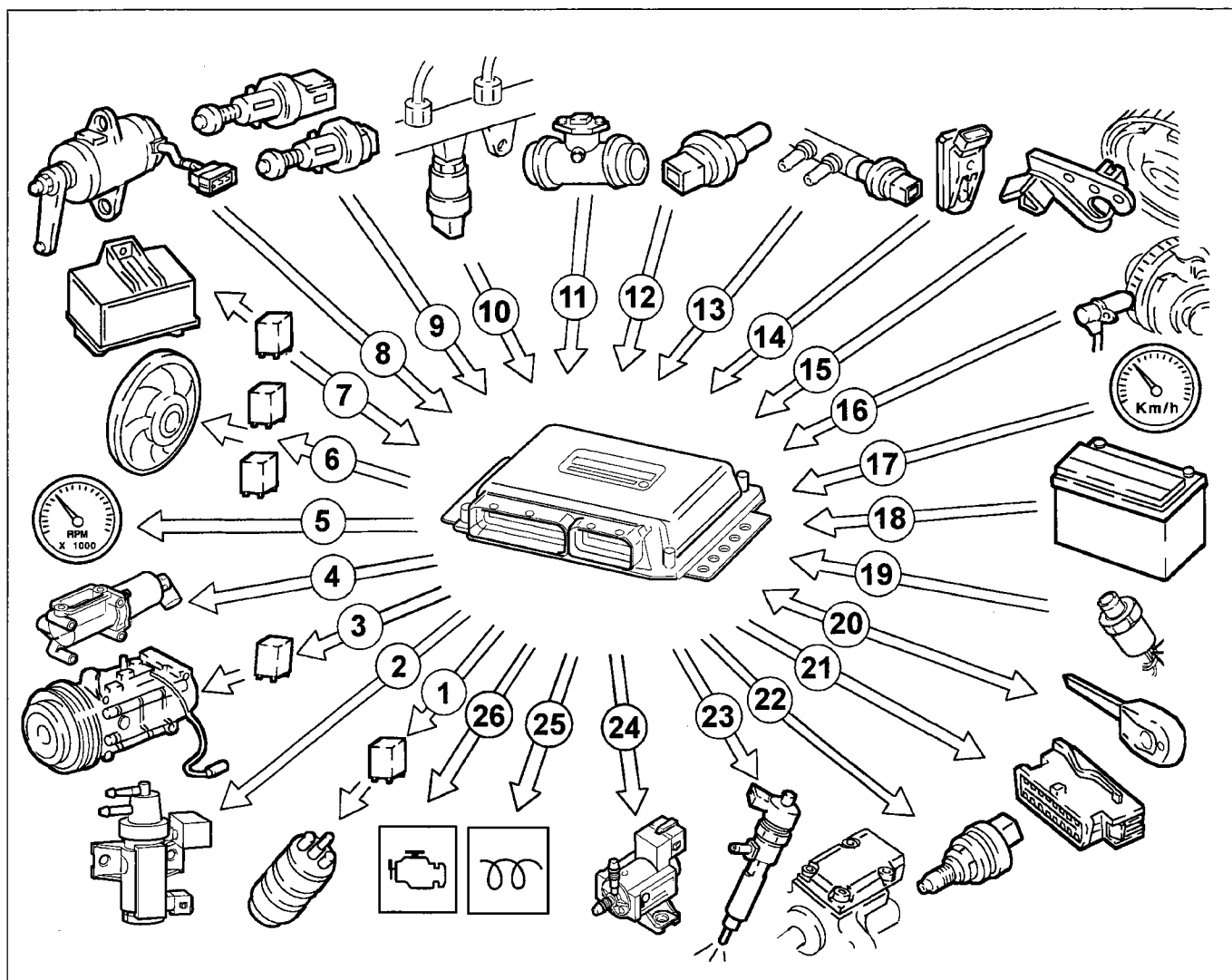
Control of throttle closing when engine is switched off

When the engine is switched off (ignition key in OFF position) the injection control unit closes the throttle valve located on the air intake duct via the special solenoid valve.

This action makes it possible to limit the tiresome shuddering of the engine whilst it is switching off.

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DIAGRAM SHOWING INFORMATION FLOW BETWEEN THE INJECTION CONTROL UNIT AND SENSORS/ACTUATORS

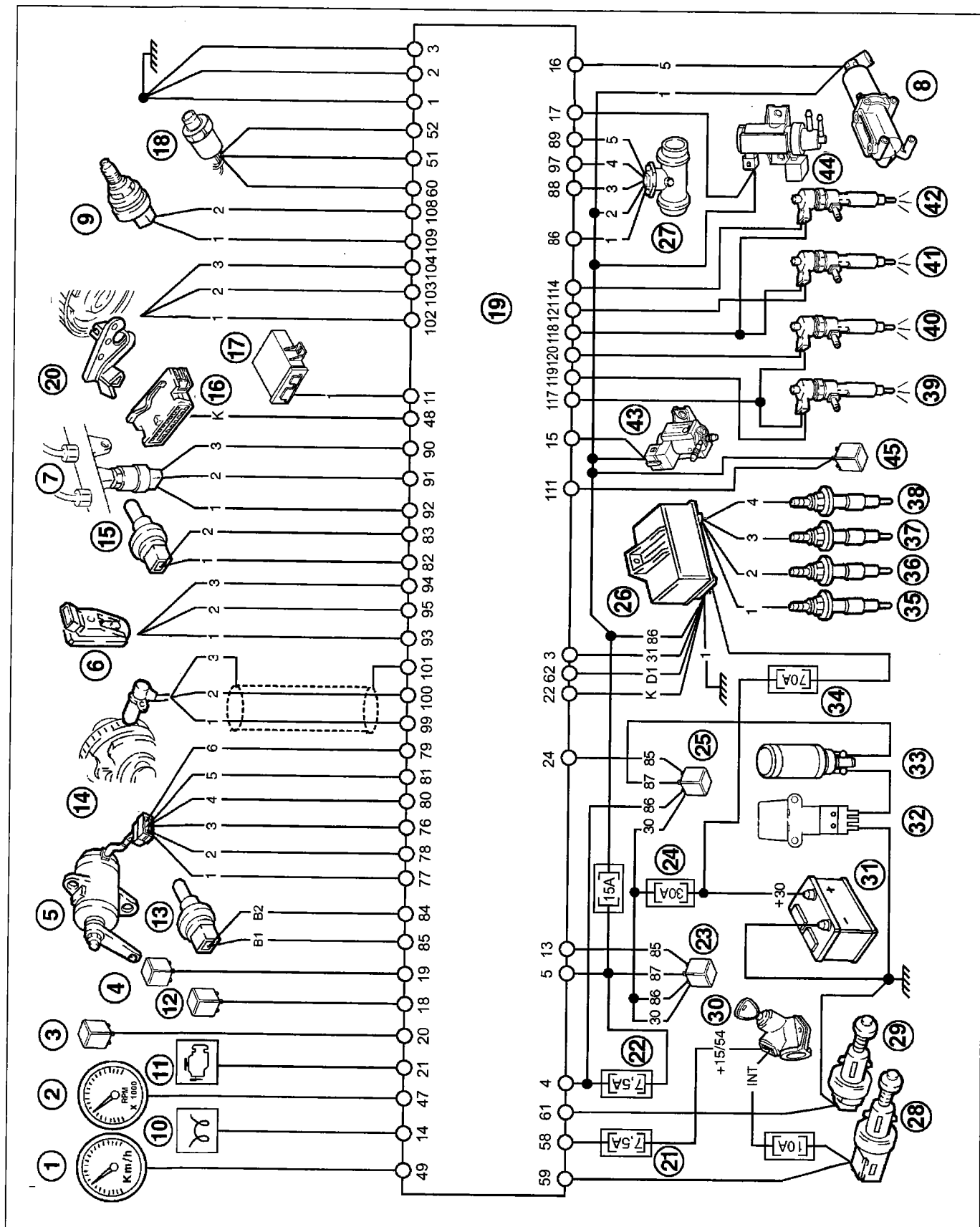


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- | | |
|--|--|
| 1. Auxiliary fuel pump | 18. Battery |
| 2. Variable geometry turbocharger control solenoid | 19. Four stage pressure switch |
| 3. Climate control compressor | 20. Fiat CODE control unit |
| 4. Electric EGR valve | 21. Diagnostic socket |
| 5. Rev counter | 22. Fuel pressure regulator |
| 6. Engine radiator fan | 23. Injectors |
| 7. Glow plug preheating control unit | 24. Throttle valve control solenoid |
| 8. Potentiometer on accelerator pedal | 25. Glow plug preheating warning light |
| 9. Brake and clutch pedal switches | 26. Injection system failure warning light |
| 10. Fuel pressure sensor | |
| 11. Intake air flow and temperature sensor (debimeter) | |
| 12. Coolant temperature sensor | |
| 13. Fuel temperature sensor | |
| 14. Pressure relief sensor | |
| 15. Timing sensor | |
| 16. Rpm sensor | |
| 17. Vehicle speed signal | |

10.

INJECTION SYSTEM WIRING DIAGRAM



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Compents of injection system wiring diagram

1. Vehicle speed
2. Rev counter
3. Engine radiator fan low speed relay
4. Radiator fan high speed activation relay
5. Potentiometer on accelerator pedal
6. Timing sensor
7. Fuel pressure sensor
8. EGR system modulator solenoid
9. Fuel pressure regulator
10. Glow plug preheating warning light on control panel
11. Injection system failure warning light
12. Air conditioning system relay
13. Coolant temperature sensor
14. Rpm sensor
15. Fuel temperature sensor
16. Diagnostic socket
17. Fiat CODE control unit
18. Four stage pressure switch
19. Injection electronic control unit
20. Pressure relief sensor
21. 7.5A fuse protecting electronic injection system (+15 power supply from ignition switch)
22. 7.5A fuse protecting electronic injection system (+30 power supply from ignition switch)
23. Main injection system relay
24. 30A fuse protecting injection system
25. Auxiliary fuel pump relay
26. Glow plug preheating control unit
27. Intake air flow and temperature sensor (debimeter)
28. Brake pedal switch
29. Clutch pedal switch
30. Ignition switch
31. Battery
32. Inertia switch
33. Auxiliary fuel pump (submerged in tank)
34. 60A fuse protecting glow plug control unit
35. Cylinder no. 1 glow plug
36. Cylinder no. 2 glow plug
37. Cylinder no. 3 glow plug
38. Cylinder no. 4 glow plug
39. Cylinder no. 1 injector
40. Cylinder no. 2 injector
41. Cylinder no. 3 injector
42. Cylinder no. 4 injector
43. Throttle valve control solenoid
44. Variable geometry turbocharger control solenoid
45. Diesel filter heater relay

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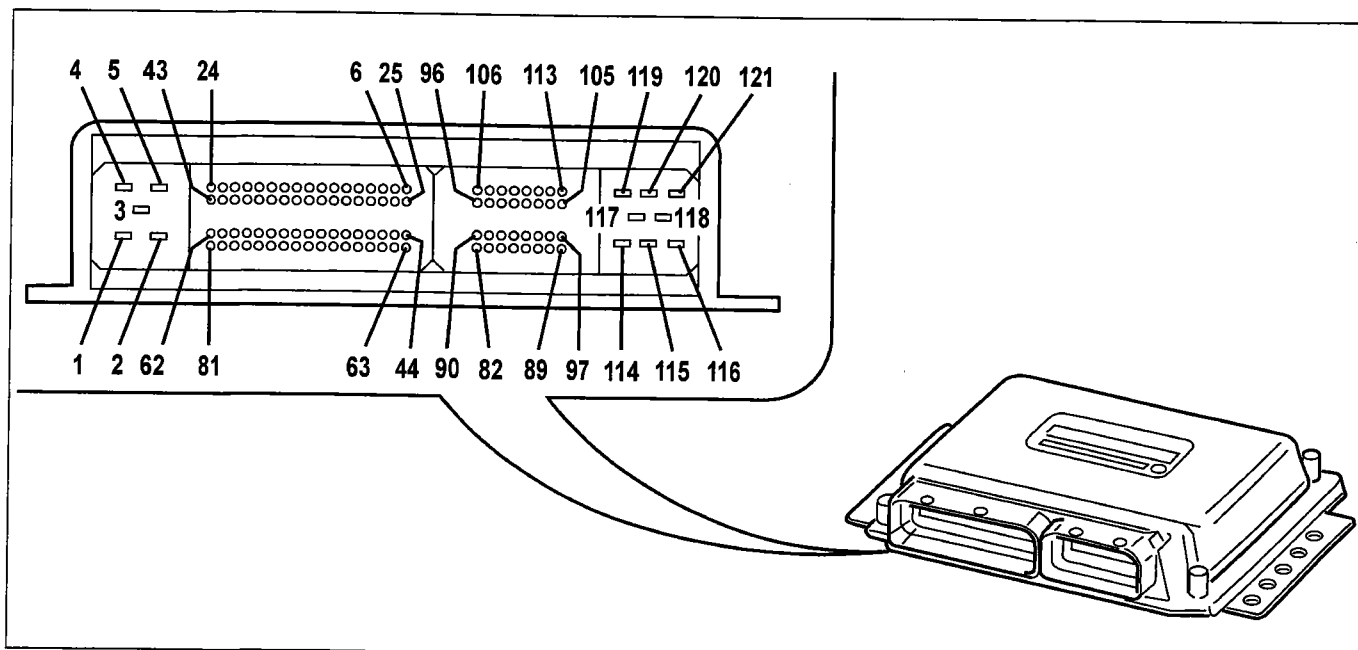
ELECTRONIC INJECTION CONTROL UNIT

The control unit processes signals from the various sensors by applying software algorithms and controls the actuators accordingly (particularly the injectors and pressure regulator) to achieve the best possible engine service conditions.

The control unit is "flash E.P.R.O.M." type, i.e. it can be reprogrammed from outside without any need to adjust the hardware.

The injection control unit contains a built-in absolute pressure sensor and is connected to the wiring by means of a 121 pin connector.

Control unit connection identification (PIN-out)



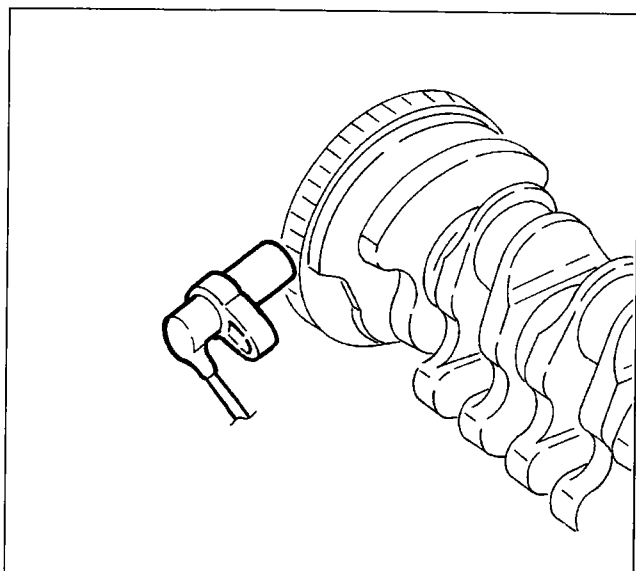
4F010XJ01

- | | |
|-------------------------------------|------------------|
| 1 Earth | 25 Not connected |
| 2 Earth | 26 Not connected |
| 3 Earth | 27 Not connected |
| 4 Actuator power supply | 28 Not connected |
| 5 Injector/ECU power supply | 29 Not connected |
| 6 Not connected | 30 Not connected |
| 7 Not connected | 31 Not connected |
| 8 Not connected | 32 Not connected |
| 9 Not connected | 33 Not connected |
| 10 Not connected | 34 Not connected |
| 11 Fiat CODE | 35 Not connected |
| 12 Not connected | 36 Not connected |
| 13 Injection relay | |
| 14 Glow plug control | |
| 15 Throttle body solenoid | |
| 16 EGR valve | |
| 17 VGT solenoid | |
| 18 Air conditioner relay | |
| 19 Radiator fan high speed relay | |
| 20 Radiator fan low speed relay | |
| 21 Diagnostic warning light control | |
| 22 Glow plug activation control | |
| 23 Not connected | |
| 24 Auxiliary fuel pump relay | |

- | | |
|---|--|
| 37 Not connected | 93 Turbo pressure sensor (pin 1) |
| 38 Not connected | 94 Turbo pressure sensor (pin 3) |
| 39 Not connected | 95 Turbo pressure sensor (pin 2) |
| 40 Not connected | 96 Not connected |
| 41 Not connected | 97 Air flow meter (pin 4) |
| 42 Not connected | 98 Not connected |
| 43 Not connected | 99 RPM sensor (pin 1) |
| 44 Not connected | 100 RPM sensor (pin 2) |
| 45 Not connected | 101 RPM sensor (pin 3) |
| 46 Not connected | 102 RPM sensor (pin 1) |
| 47 Engine rpm signal output | 103 Timing sensor (pin 2) |
| 48 Diagnostic line k | 104 Timing sensor (pin 3) |
| 49 Vehicle speed signal input | 105 Not connected |
| 50 Not connected | 106 Not connected |
| 51 Activation signal from 4-stage pressure switch | 107 Not connected |
| 52 Activation signal from 3-stage pressure switch | 108 Fuel pressure regulator |
| 53 Not connected | 109 Fuel pressure regulator |
| 54 Not connected | 110 Not connected |
| 55 Not connected | 111 Heater relay control Fuel filter |
| 56 Not connected | 112 Not connected |
| 57 Not connected | 113 Not connected |
| 58 Key ON signal | 114 Cylinder 4 injector control |
| 59 Brake switch | 115 Not connected |
| 60 Air conditioner activation request | 116 Not connected |
| 61 Clutch switch | 117 Cylinder 1 and 2 injector power supply |
| 62 Glow plug diagnosis | 118 Cylinder 3 and 4 injector power supply |
| 63 Not connected | 119 Cylinder 1 injector control |
| 64 Not connected | 120 Cylinder 2 injector control |
| 65 Not connected | 121 Cylinder 3 injector control |
| 66 Not connected | |
| 67 Not connected | |
| 68 Not connected | |
| 69 Not connected | |
| 70 Not connected | |
| 71 Not connected | |
| 72 Not connected | |
| 73 Not connected | |
| 74 Not connected | |
| 75 Not connected | |
| 76 Accelerator pedal 1 earth | |
| 77 Accelerator pedal 1 signal | |
| 78 Accelerator pedal 1 power supply | |
| 79 Accelerator pedal 2 earth | |
| 80 Accelerator pedal 2 signal | |
| 81 Accelerator pedal 2 power supply | |
| 82 Diesel temperature sensor (pin 1) | |
| 83 Diesel temperature sensor (pin 2) | |
| 84 Coolant temperature sensor (pin 1) | |
| 85 Coolant temperature sensor (pin 2) | |
| 86 Air flow meter (pin 1) | |
| 87 Not connected | |
| 88 Air flow meter (pin 3) | |
| 89 Air flow meter (pin 5) | |
| 90 Fuel pressure sensor (pin 3) | |
| 91 Fuel pressure sensor (pin 2) | |
| 92 Fuel pressure sensor (pin 1) | |



10.



4F012XJ01

RPM SENSOR

The rpm sensor is fitted to the engine crankcase and faces the phonic wheel on the crankshaft.

The sensor is inductive type, i.e. it works by varying a magnetic field generated when the phonic wheel teeth (60-2 teeth) pass in front of the sensor element.

The injection control unit uses the rpm sensor signal to determine crankshaft speed and angular position.

Operation

The changeover from full to empty due to the presence or absence of teeth sets up a magnetic flux change sufficient to generate an induced alternating voltage proportional to the number of teeth on the phonic wheel.

The peak sensor output voltage value, all things being equal, depends on the distance between the sensor and the tooth (gap).

1. Steel bush
2. Permanent magnet
3. Sensor case
4. Winding
5. Core
6. Phonic wheel
7. Electrical connection

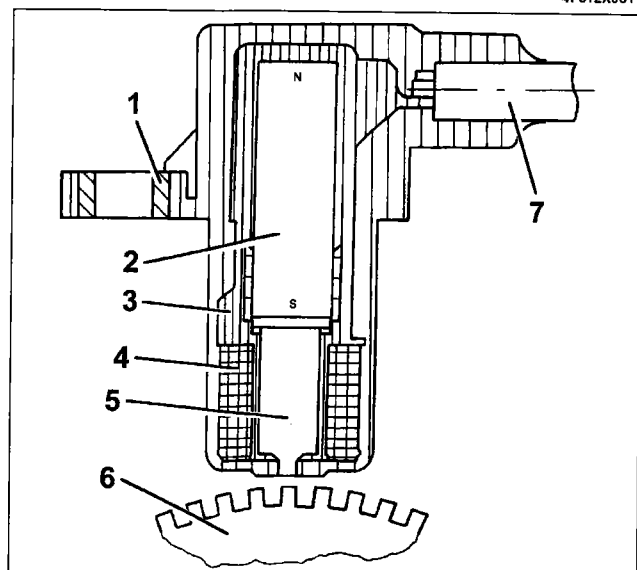
To obtain the correct signal, the specified gap between phonic wheel and sensor should be between 0.8 and 1.5 mm

This distance is not adjustable. When the gap is not as specified, check the condition of the sensor and phonic wheel.

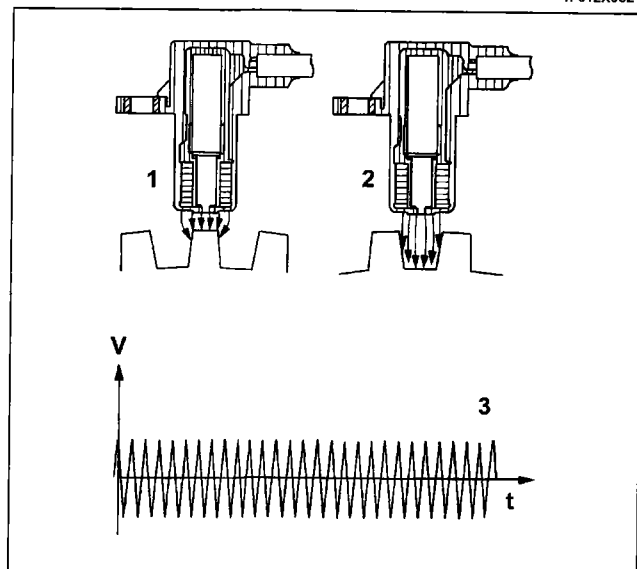
Winding resistance

860 Ohm $\pm 110\%$ at 20 °C

1. Maximum magnetic flux
2. Minimum magnetic flux
3. Induced alternate voltage



4F012XJ02



4F012XJ03

TIMING SENSOR

The Hall effect sensor is fitted to the cylinder head and faces the camshaft pulley.

An opening on the pulley allows the timing sensor to detect the engine timing position and indicate it to the injection control unit.

The injection control unit uses the timing sensor signal to detect TDC at the end of compression.

Operation

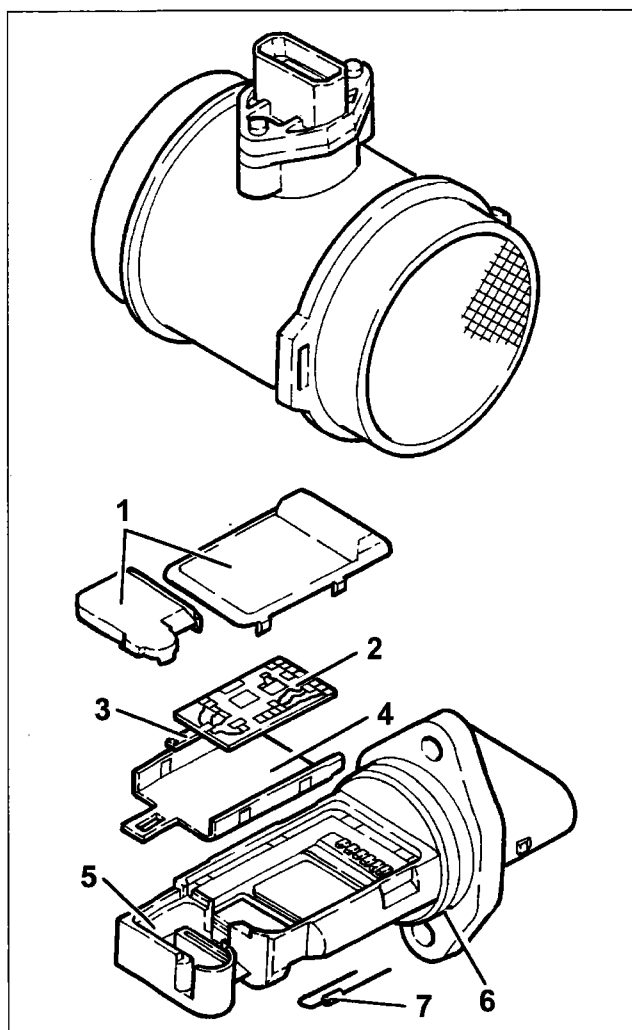
A semi-conductor layer, through which a current passes, immersed in a magnetic field (lines of force perpendicular to the direction of the current), produces a difference in power, known as Hall voltage.

If the intensity of the current remains constant, the voltage produced only depends on the intensity of the magnetic field. The intensity of the field can simply be altered periodically to produce a modulated electrical signal. Signal frequency is proportional to the speed with which the magnetic field changes.

To achieve this change, the sensor is crossed by a metal ring (inner part of the pulley) with an opening.

When it moves, the metal part of the ring covers the sensor to magnetic field and the output signal is therefore low; Conversely, the sensor generates a high signal at the opening when the magnetic field is present.

This signal, together with the rpm and TDC signals, allows the injection control unit to identify piston position and determine injection point.



4F013XJ01

AIR FLOW METER (DEBIMETER)

The debimeter is located on the air intake sleeve and is hot film type.

The debimeter contains an intake air temperature sensor.

Operation

The principle of operation is based on a heated membrane fitted into a measurement channel through which engine intake air flows.

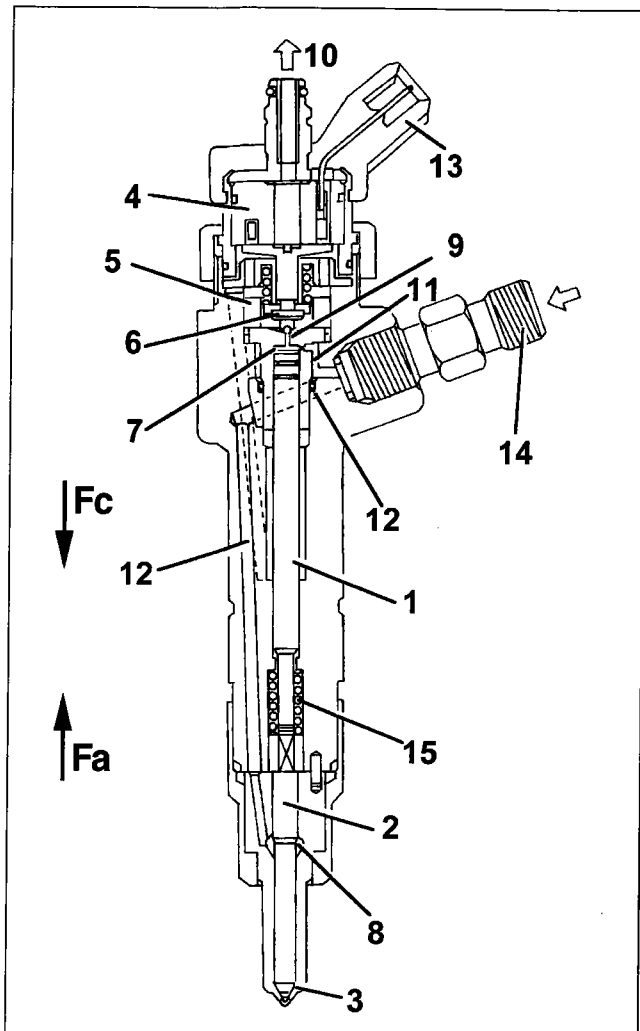
The hot film membrane is maintained at a constant temperature (about 120 °C higher than incoming air) by the heater coil.

The mass of air flowing through the measurement channel tends to take heat from the membrane. To keep the membrane at constant temperature, a certain current level must flow through the resistance.

Because this current is proportional to the mass of air that flows to the engine, it can be measured with a Wheatstone bridge and the resulting signal is sent to the injection control unit.

1. Covers
2. Electronic card
3. Sensor
4. Mounting plate
5. Mount
6. o-ring
7. Temperature sensor

10.



4F014XJ01

INJECTORS

The injectors are fitted to the cylinder head and are electromagnetic in type. They are controlled directly by the injection control unit.

The injectors come with a high-pressure supply port and a recirculation pipe at environmental pressure; The supply port is connected to a delivery manifold (rail) with pipes designed to withstand the high service pressures.

The injector can be divided into two parts:

- Actuator/spray made up of a pressure rod (1), pin (2) and nozzle (3);
- control solenoid made up of coil (4) and pilot valve (5).

Operation

Injector operation may be divided into three stages:

1. rest position

Coil (4) is deactivated and plunger (6) is in closed position to prevent fuel entering the cylinder: $F_c > F_a$ where F_c is the force generated by pressure acting on the control area (7) of pressure rod (1) and F_a is the force due to the pressure acting on supply volume (8).

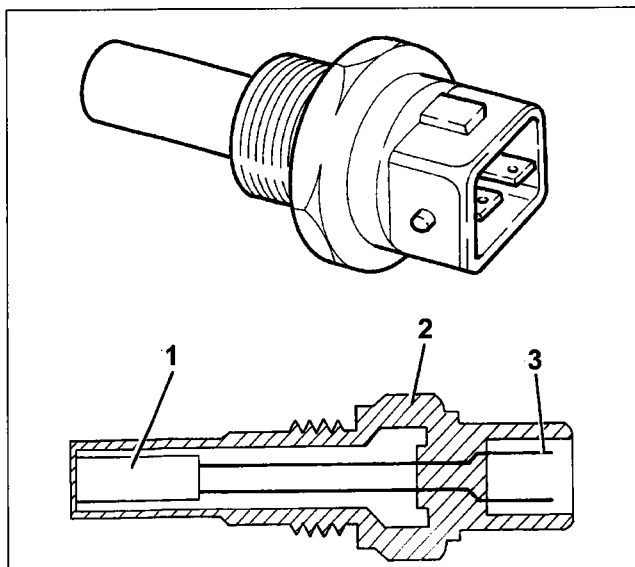
2. Start of injection

Coil (4) is excited and causes plunger (6) to rise. Fuel flows from control volume (9) to the return manifold to bring about a pressure drop in control area (7). Simultaneously, line pressure through supply port (12) exerts a force $F_a > F_c$ on supply volume (8) to cause pin (2) to rise and thus allow fuel into the cylinders.

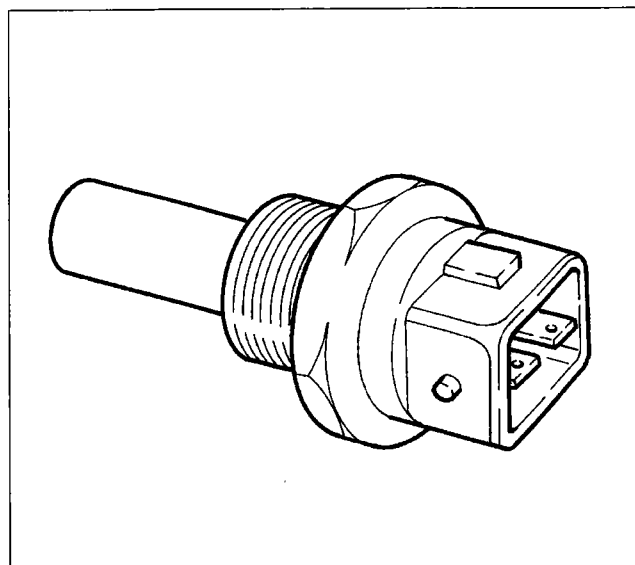
3. end of injection

Coil (4) is deactivated and causes plunger (6) to return to closed position. The resulting balance of forces makes pin (2) return to rest position and injection therefore ends.

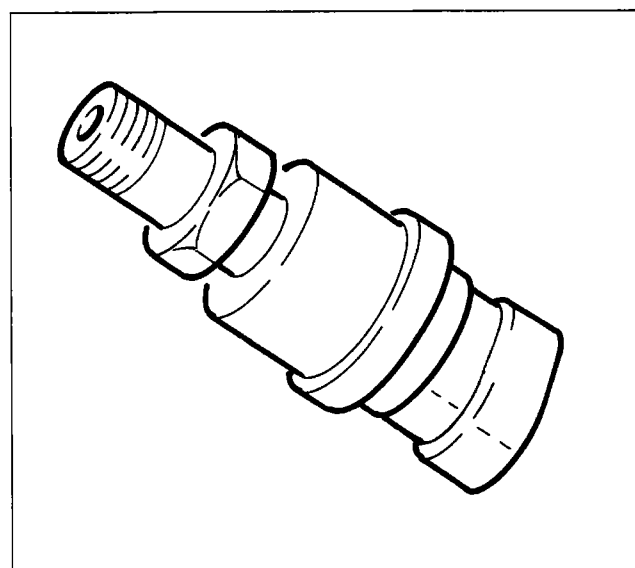
1. Pressure rod
2. Pin
3. Nozzle
4. Coil
5. Pilot valve
6. Ball plunger
7. Control area
8. Supply volume
9. Control volume
10. Fuel outlet connector (low pressure)
11. Control port
12. Supply port
13. Electrical connection
14. Fuel input connector (high pressure)
15. Spring



4F015XJ01



4F015XJ02



4F015XJ03

ENGINE COOLANT TEMPERATURE SENSOR

The sensor is fitted to the thermostat and measures the temperature of the engine coolant by means of an NTC thermistor with a negative resistance coefficient.

Because the sensor is made using semiconductor technology, the resistance falls if sensor element temperature rises with increasing coolant temperature.

Because resistance does not change in linear manner, it is higher at low temperatures than at high temperatures for the same temperature increase.

1. NTC resistance
2. Sensor case
3. Electrical connector

FUEL TEMPERATURE SENSOR

The sensor is fitted on the return manifold and measures fuel temperature by means of an NTC thermistor with a negative resistance coefficient.

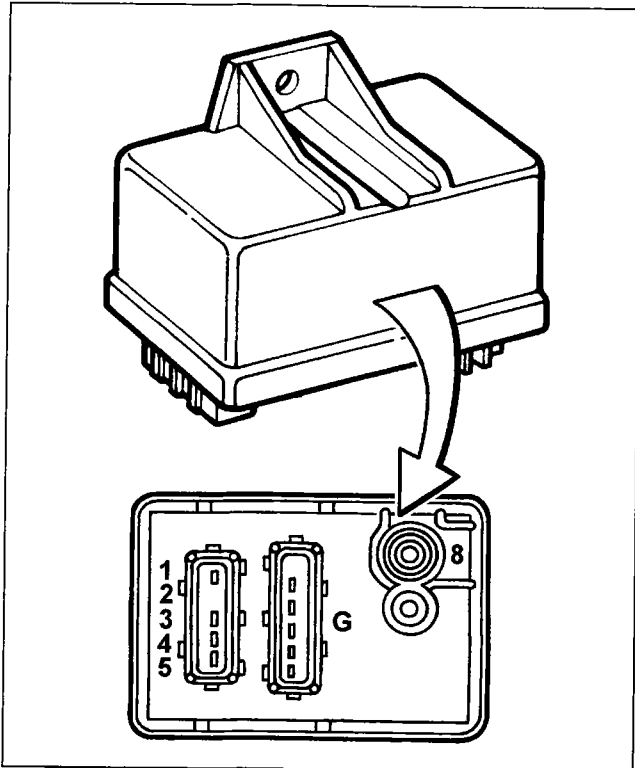
Refer to the previous description of the coolant temperature sensor for sensor operation.

FUEL PRESSURE SENSOR

The sensor is fitted in the middle of the fuel delivery manifold (rail) and is responsible for providing a return signal (feedback) to the control unit in order to:

- adjust injection pressure;
- regulator injection duration.

10.



4F016XJ01

GLOW PLUG PREHEATING CONTROL UNIT

The glow plugs are controlled by means of a preheating control unit under the direct control of the injection control unit.

The preheating control unit contains a smart relay that sends a return response (feedback) to the injection control unit, which is thus informed of faults in the preheating control unit or glow plug short-circuits to earth.

The figure shows the connectors on the base of the preheating control unit and the pin-out

1. Earth
2. Injection control unit (pin 22)
3. Power supply from main injection relay
4. Not connected
5. Injection control unit (pin 62)
8. Positive from battery (+30)
- G. Glow plugs (only four outputs are used)

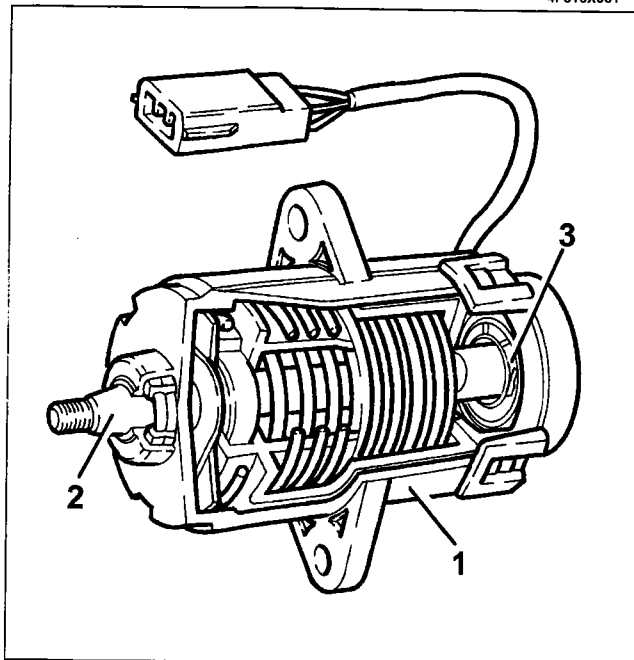
**ACCELERATOR
PEDAL POTENTIOMETER**

Accelerator pedal position is converted to an electrical voltage signal and send to the injection control unit by a potentiometer connected to the accelerator pedal.

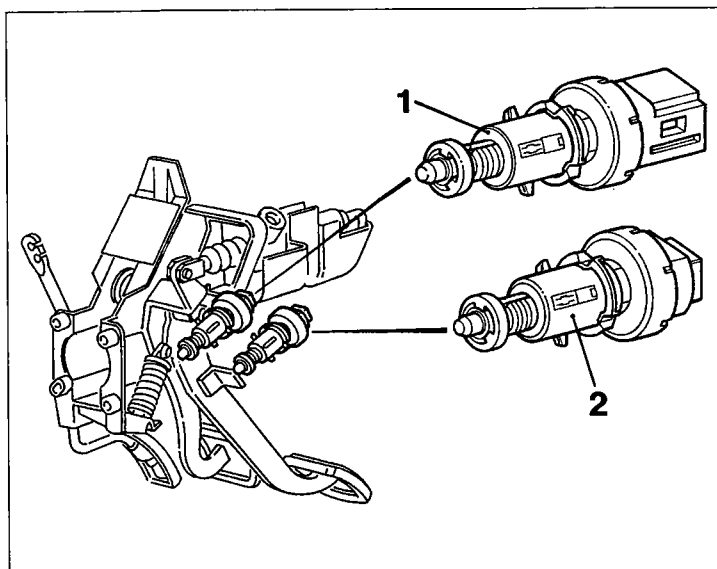
Accelerator pedal position is processed together with rpm information to provide injection times and pressure.

The sensor consists of a case (1) secured to the pedal by a flange, which contains an axially-positioned shaft (2) connected to two potentiometers (3): main and safety potentiometers.

A coil spring on the shaft ensures the correct resistance to pressure while a second spring ensures return upon release.



4F016XJ02



4F017XJ01

TEST

A switch (1) on the brake pedal controls the car brake lights; the same switch sends a signal to pin 59 of the injection control unit

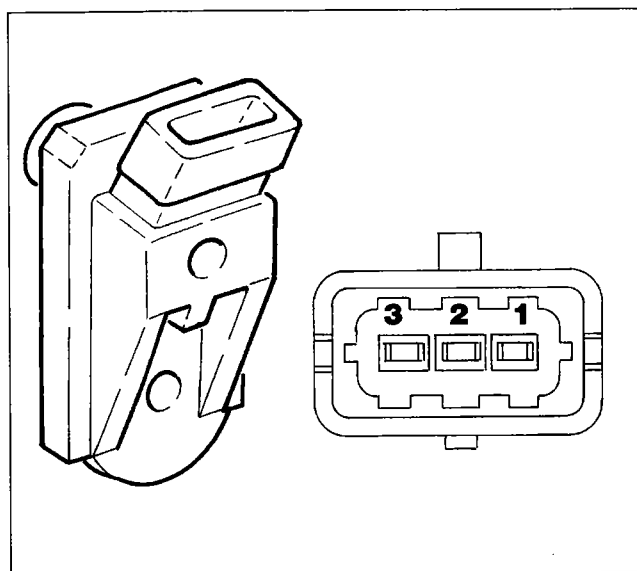
The control unit uses the "brake pedal depressed" signal to:

- detect a situation of over-run;;
- check the plausibility of the signal from the accelerator potentiometer

CLUTCH PEDAL SWITCH

A switch (2) on the clutch pedal is connected to pin 61 of the injection control unit.

The injection control unit uses the "brake pedal operated" signal to distinguish gear engaged and gear shift conditions.



4F017XJ02

PRESSURE RELIEF SENSOR

The sensor is fitted to the intake manifold and the signal sent to the injection control unit is used to:

- regulate injection pressure;
- regulate injection duration.

The figure alongside shows the sensor and electrical connector with the following pin-out:

1. pressure signal
2. Earth
3. Fuel feed system

ATMOSPHERIC PRESSURE SENSOR

The atmospheric pressure signal is built into the injection control unit. It is responsible for measuring atmospheric pressure in order to correct measured air flow and reference air flow values to control the EGR function.

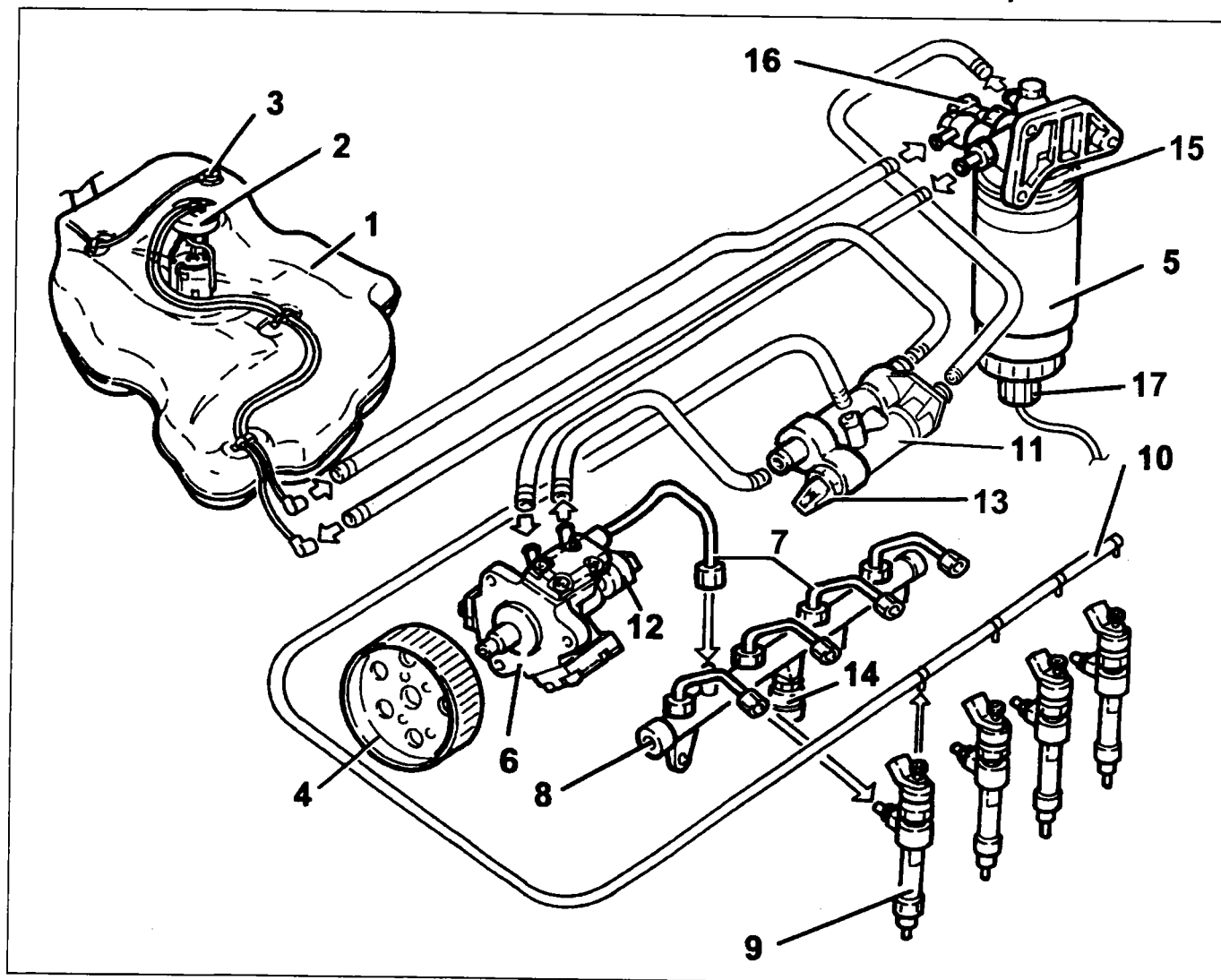
10.

FUEL SUPPLY CIRCUIT

Operationally-speaking, the fuel supply circuit is divided into a low pressure circuit and a high pressure circuit.

The low pressure circuit consists of a tank, multifunction valve, auxiliary fuel pump submerged in the tank and a return manifold.

The high pressure circuit consists of a radialjet pressure pump, delivery manifold and injectors.



4F018XJ01

- | | |
|--|--|
| 1. Fuel tank | 14. Fuel pressure sensor |
| 2. Submerged fuel pump (auxiliary) with fuel level gauge control | 15. Diesel heater |
| 3. Multifunction valve | 16. Fuel temperature sensor |
| 4. Pressure pump control pulley | 17. Sensor indicating presence of water in fuel filter |
| 5. Diesel filter cartridge | |
| 6. Pressure pump | |
| 7. High pressure pipe | |
| 8. Delivery manifold (rail) | |
| 9. Injectors | |
| 10. Fuel recirculation pipe (injector return) | |
| 11. Return manifold | |
| 12. Pressure regulator | |
| 13. Fuel temperature sensor | |

10.

SUBMERGED FUEL PUMP ASSEMBLY (AUXILIARY) AND LEVEL GAUGE CONTROL

The assembly consists mainly of:

- a roller-type fuel pump;
- a fuel level gauge;
- a fuel filter

The submerged fuel pump is volumetric type with rollers and a motor with brushes and permanent magnet excitation.

Impeller (1) is driven by the electric motor to turn and create volumes (2) that move from intake port (3) to outlet port (4).

These volumes are delimited by rollers (5) that adhere to outer race (6) as the motor turns.

The pump is fitted with two valves: a check valve to prevent the fuel circuit emptying (with the pump off); a second pressure relief valve (7) that short-circuits the outlet to the inlet when pressures exceed 5 bars.

FUEL FILTER

The fuel filter is located in the engine bay.

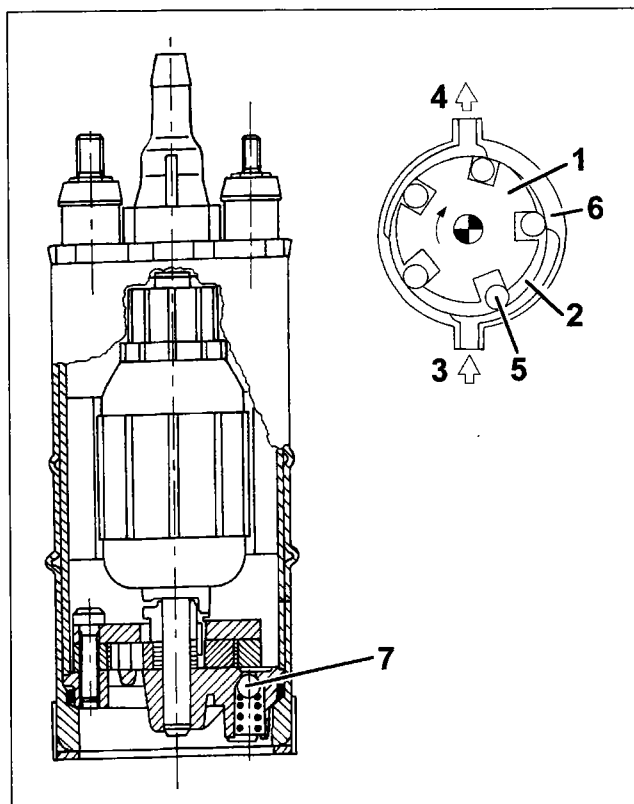
The filter is cartridge type with a filter element (1) made up of a pack of paper discs with a filtering area of some 5300 cm² and a filter gauge of 4 - 5 microns.

The filter is equipped with a fuel preheating device (2) controlled by the engine control unit via a relay.

The control unit activates or deactivates the diesel filter on the basis of a diesel temperature signal sent by sensor (3) on the filter.

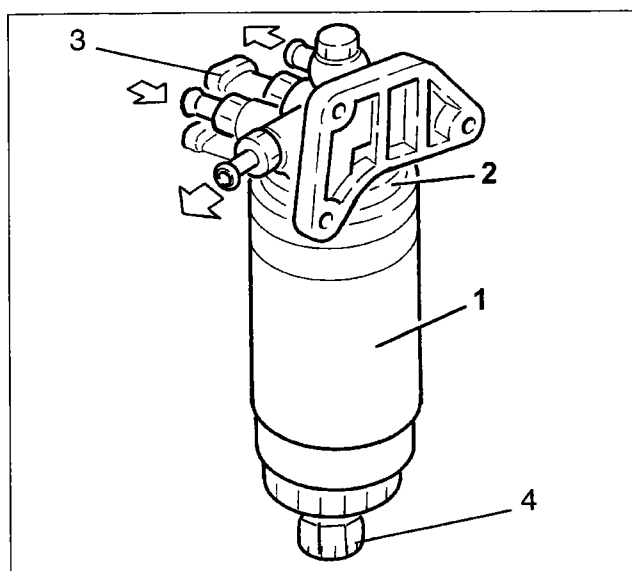
A plug (4) screwed to the base of the fuel filter cartridge is used to drain off the water. The plug incorporates a sensor for the detection of water in the diesel filter connected to a warning light on the instrument panel.

1. Filter cartridge
2. Diesel preheating device
3. Diesel temperature sensor
4. Water drain plug with sensor to detect presence of water in diesel filter



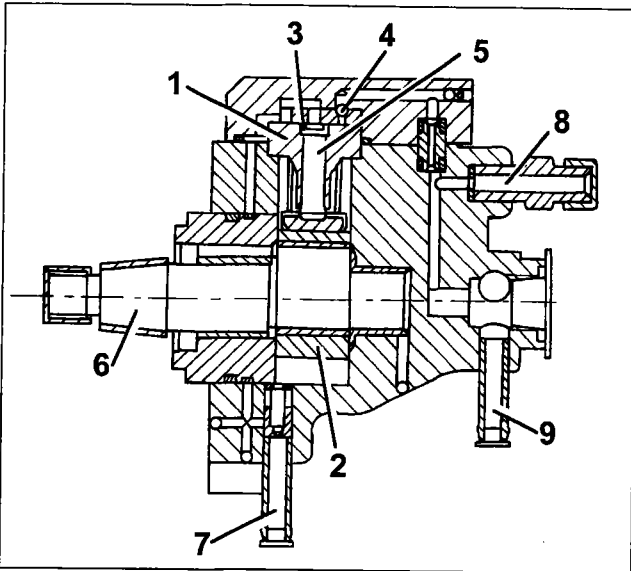
4F019XJ01

1. Impeller
2. Volumes
3. Intake port
4. Outlet port
5. Rollers
6. Outer race
7. Pressure relief valve

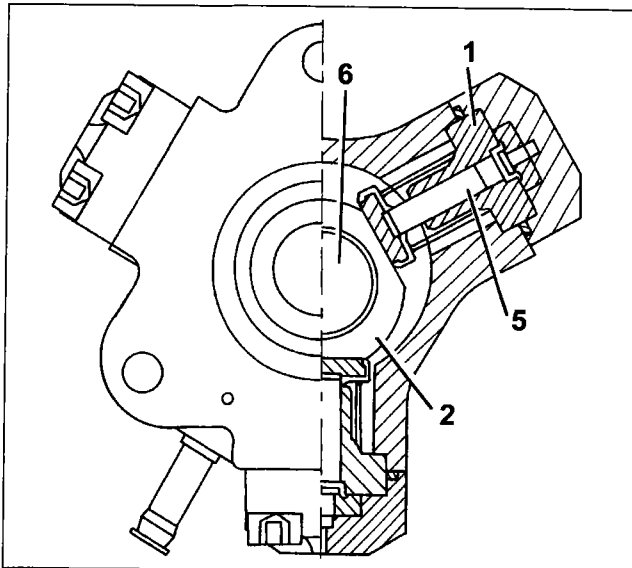


4F019XJ02

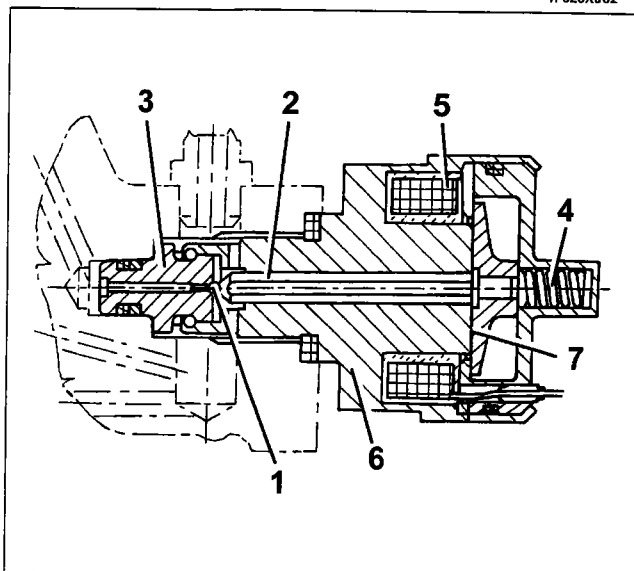
10.



4F020XJ01



4F020XJ02



4F020XJ03

PRESSURE PUMP

The pressure pump is radialjet type with three radial pistons (total capacity 0.657 cc). It is controlled by a timing belt with or without timing requirements.

Each pump unit consists of:

a piston (5) operated by a cam (2) integral with the pump shaft (6);

a plate-type intake valve (3);

a delivery ball valve (4).

The pressure pump must be supplied at a pressure of at least 0.5 bars; and for this reason the fuel system is equipped with an auxiliary pump submerged in the tank.

The pressure pump is lubricated and cooled by the diesel fuel via channels and is able to deliver a maximum pressure of 1350 bars.

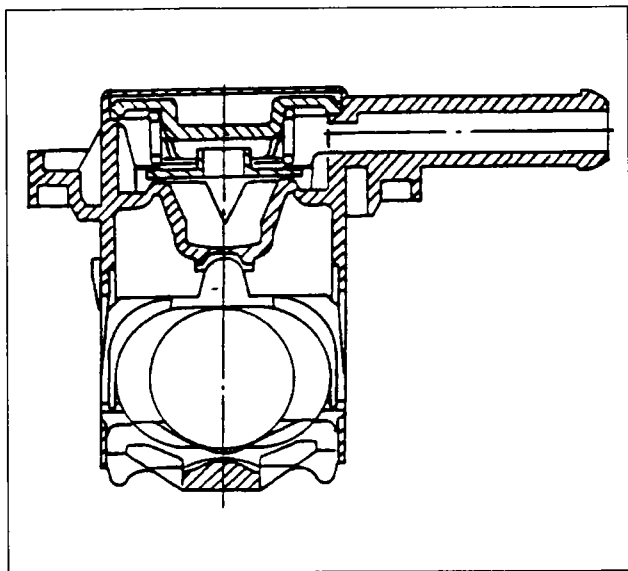
1. Cylinder
2. Cam
3. Plate-type intake valve
4. Ball-type delivery valve
5. Piston
6. Pump shaft
7. Diesel intake connection - low pressure - from fuel filter
8. Diesel delivery connection - high pressure - to manifold (rail)
9. Diesel delivery connection - low pressure - recirculation

**PRESSURE REGULATOR
FILTER**

The fuel pressure regulator is fitted to the pressure pump and controlled directly by the injection control unit. It regulates fuel feed pressure to the injectors.

The pressure regulator consists mainly of the following parts:

1. Ball plunger
2. Pin
3. Valve
4. Preload spring
5. Coil
6. Body
7. Anchor



4F021XJ01

MULTIFUNCTION VALVE

The multifunction valve is located on the fuel tank and performs the following functions:

- tank pressurisation
- ventilation
- seal if the car rolls over

Tank pressurisation

Tank pressurisation is maintained at a level between 55 and 75 mbars by means of a valve mounted on a sealing rim.

The valve is supported by a steel plate and held in place by a spring.

When tank pressure exceeds a specified level, it overcomes spring resistance and allows the valve to rise so that vapours can flow out.

When the pressure returns to within specified limits, the valve closes again

Ventilation

Under certain car service conditions, a vacuum may build up in the tank due to the effect of:

- heat changes;
- fuel consumption

in this case, the valve's function is to make up pressure inside the tank by letting air into the tank.

If this function is not performed correctly, the car may judder or stall due to difficulties in supplying the pump.

Seal if the car rolls over

The roll-over function prevents fuel emerging from the tank if the car rolls over or tilts to a great extent. During normal car operation (bends, acceleration, braking etc.), the fuel slops about and may emerge. The highly-sensitive roll-over valve prevents this happening.

DELIVERY MANIFOLD (RAIL)

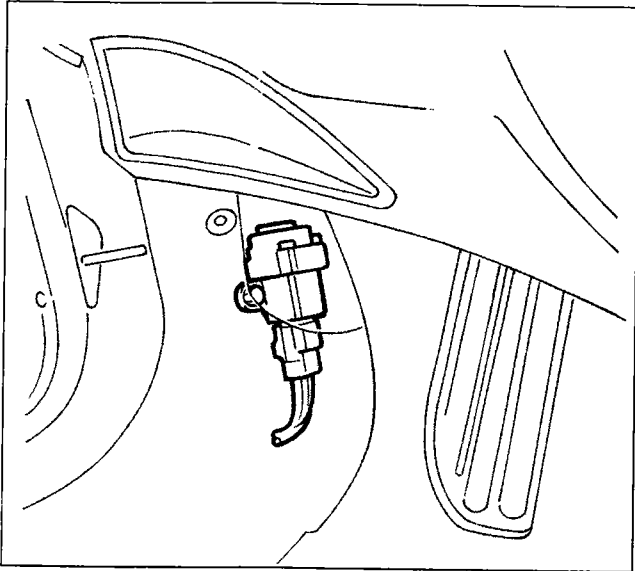
The delivery manifold (rail) is fitted to the cylinder head on the intake side.

Its volume damps fuel pressure fluctuations due mainly to:

- operation of the pressure pump;
- injector opening.

A fuel pressure sensor is fitted in the middle of the delivery manifold. Hydraulic connections (high pressure) are via special steel pipes.

10.



4F022XJ01

INERTIA SAFETY SWITCH

To increase car occupant safety in the case of impact, the car is fitted with an inertia switch located inside the passenger compartment secured to the inside of the left panel.

This sensor reduces the possibility of fire (due to emerging fuel) by deactivating the auxiliary fuel pump that supplies the injection circuit.

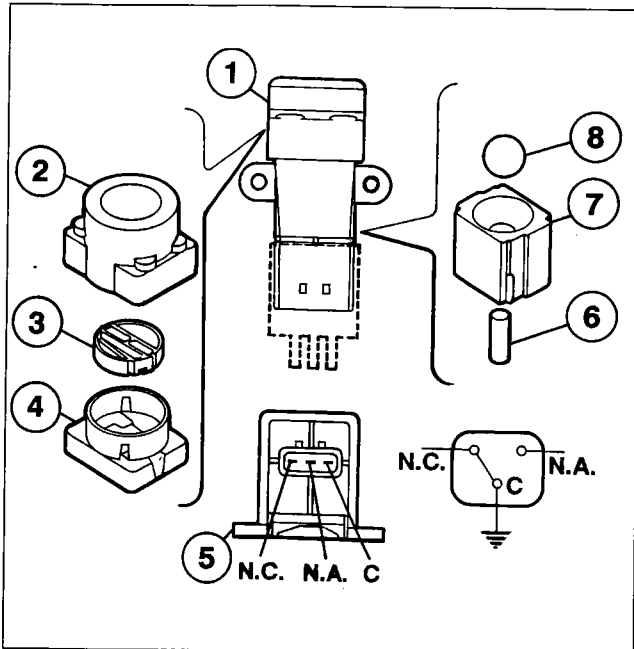
The switch consists of a steel ball, fitted in a tapered housing, kept in place by the attraction force of a permanent magnet.

In the case of violent impact, the ball is released from the magnetic detent and opens the normally closed (NC) electrical circuit to cut off the auxiliary fuel pump connection to earth, and as a consequence the supply to the injection system.

To restore the auxiliary pump earth connection, move back the seat and press the switch until a click is heard.



Even after an apparently slight impact, if there is a smell of fuel or there are leaks from the fuel system, do not turn the switch back on, but search for the fault and remedy it to prevent the risk of fire.



4F022XJ02

Inertia switch components

1. Inertia switch assembly
2. Sheath
3. Button
4. Upper side
5. Engagement side
6. Permanent magnet
7. Permanent magnet seat
8. Steel ball

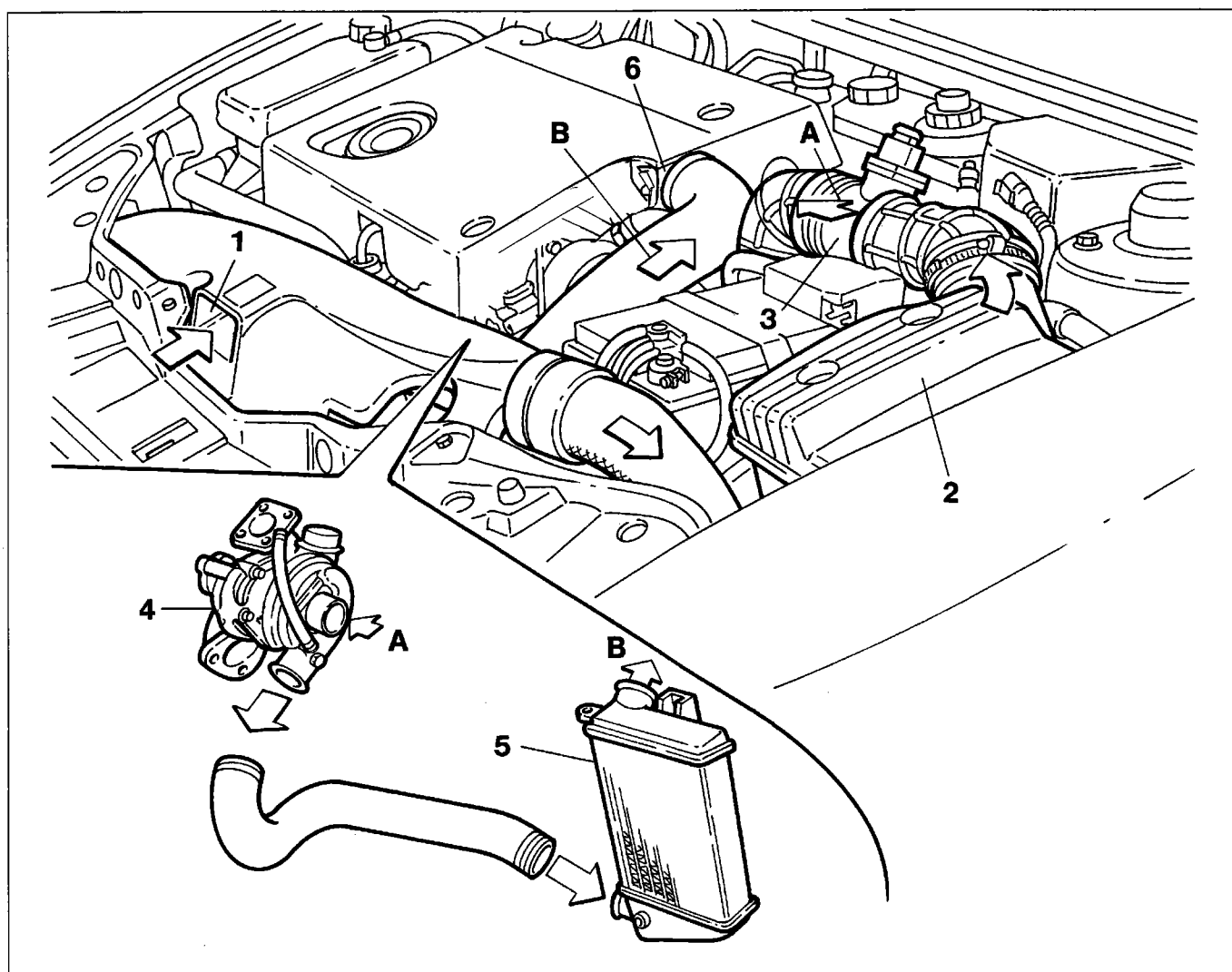
C Common terminal
N.C. Normally closed contact
N.A. Normally open contact

AIR INTAKE CIRCUIT

The air intake circuit is turbocharged by means of a GARRET variable geometry turbocharger and an intercooler.

The turbocharger is low inertia type. Its design is based on a new principle of turbocharging whereby the turbocharger aims to increase torque within the range of most frequent use (e.g. at low speeds).

After passing through the filter (1), intake air is compressed by the exhaust gas-drive turbocharger (4), cooled by intercooler (5) and sent to throttle body (6) and the intake manifold from where it is distributed to the cylinders.

Air intake circuit diagram

4F023XJ01

1. Intake vent
2. Air filter
3. Intake air flow meter (debimeter)
4. Variable geometry turbocharger
5. Air-air intercooler
 - A. To turbocharger
 - B. To intake manifold
6. Throttle body

10.

THROTTLE BODY

To reduce engine noise during shut-down, a throttle has been added to the intake port with the aim of closing off the air flow to the cylinders.

Throttle valve opening or closure is controlled by an engine control unit (5) that manages a control actuator (3) on throttle body (4) via solenoid (2).

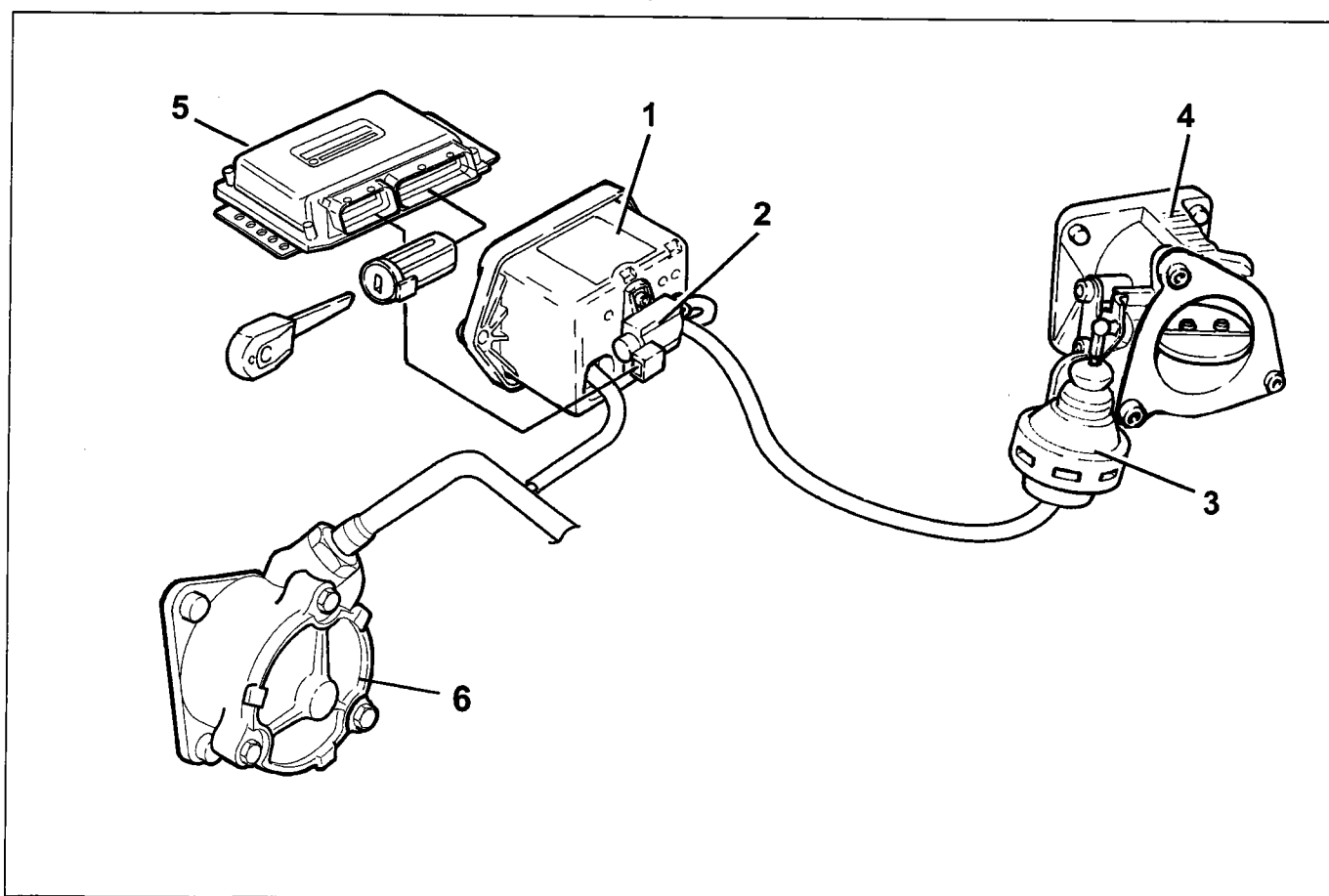
Operation

When the engine is off, the throttle is open because no vacuum is present.

When the engine is running, the throttle is open because the Pierburg solenoid is not activated and prevents the vacuum reaching the pneumatic actuator.

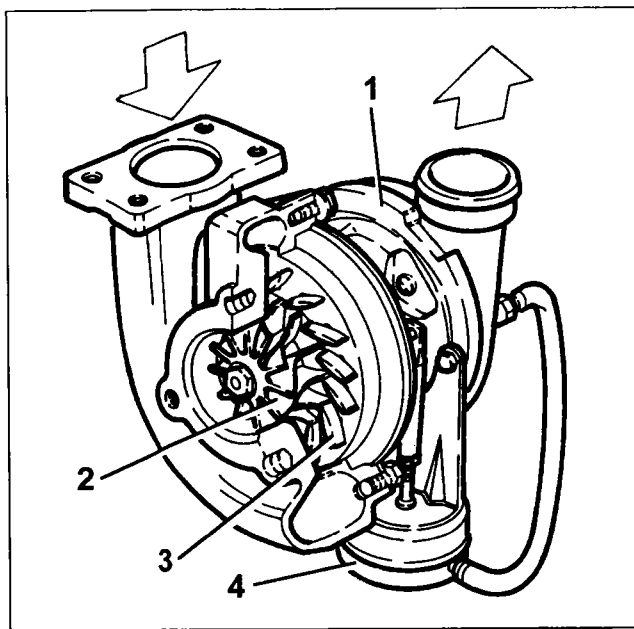
A vacuum builds up in the tank during engine operation.

During engine shut-down (when the ignition key is turned OFF), the control unit keeps the actuator supply relay activated for a further 4 or 5 seconds and simultaneously earths the Pierburg valve. The Pierburg valve opens to send the vacuum that has built up in the vacuum tank to the pneumatic actuator, which closes the throttle to cut off the flow of air to the cylinders.

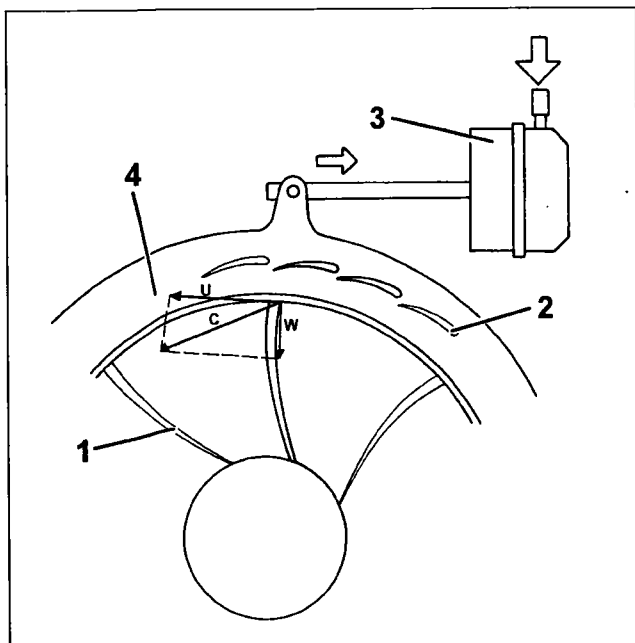


4F024XJ01

1. Vacuum tank;
2. Pierburg solenoid controlling throttle body actuator;
3. Pneumatic actuator on throttle body
4. Throttle body
5. Engine control unit
6. Vacuum pump



4F025XJ01



4F025XJ02

TURBOCHARGER (1910 JTD 110 CV)

The turbocharger used in the application of the EURO 3 standards in the variable geometry type connected to the exhaust manifold.

The turbocharger is controlled by the engine management control unit via a duty-cycle solenoid valve.

The increased volumetric output for the engine is achieved, in the case of variable geometry compressors, through the use of:

- a centrifugal compressor (1)
- a turbine (2)
- a series of moving vanes (3)
- a pneumatic actuator (4) controlling the moving vanes.
- a solenoid valve (5) controlling the actuator

The variable geometry turbocharger makes it possible to:

- increase the speed of the exhaust gases in the turbine at low engine speeds
- slow down the speed of the exhaust gases in the turbine at high speeds.

The control of the speed (kinetic energy) of the exhaust gases makes it possible to produce increased engine torque at low speeds and greater maximum power at high speeds.

Operation at low rotation speeds

When the engine is operating at low speeds, the exhaust gases possess little kinetic energy: under these circumstances a conventional turbine would rotate slowly, supplying a limited supercharging pressure.

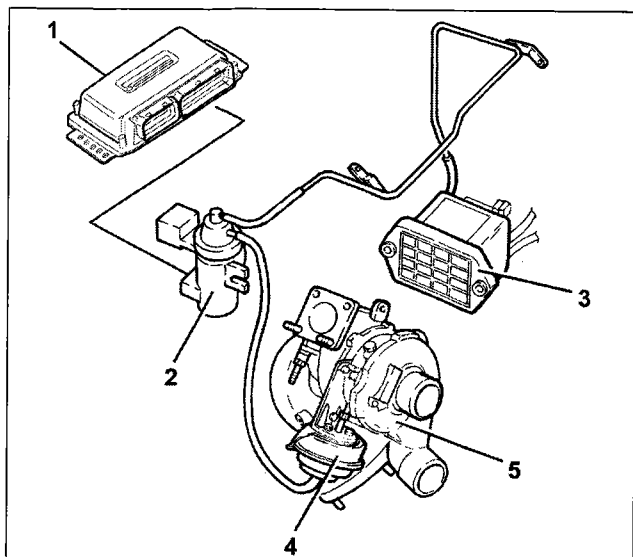
On the other hand, in the variable geometry turbine (1), the moving vanes are in the maximum closure position and the small passage sections between the vanes increase the speed (C) of the intake gases.

Increased intake speeds lead to increased peripheral speeds (U) of the turbine and, consequently, the compressor.

The speed of the gases inside the impeller is indicated by the vector (W).

1. Turbine
2. Moving vanes
3. Pneumatic actuator
4. Rotary seal

10.



4F026XJ01

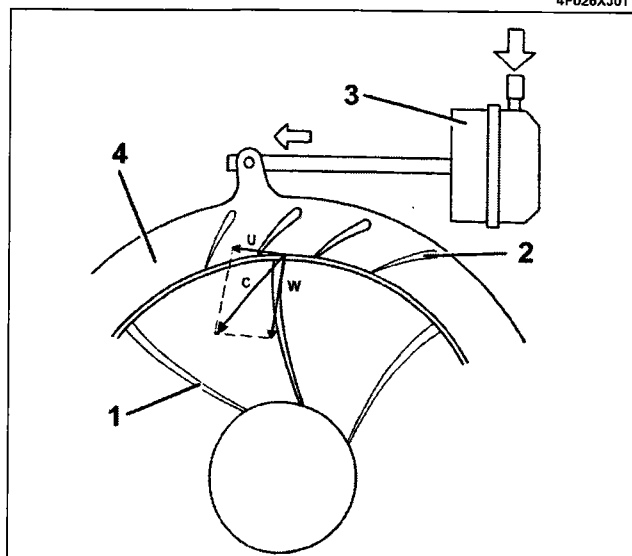
Operation at high rotation speeds

When the engine speed is increased, the kinetic energy of the exhaust gases increases gradually.

As a result, the speed of the turbine (5) increases and consequently the supercharging pressure.

The VGT solenoid valve (2) operated by the injection control unit (1), through the actuator (4) causes the moving vanes to change position until the maximum opening position is reached.

1. Injection control unit
2. VGT solenoid valve
3. Vacuum reservoir
4. Pneumatic actuator
5. Turbine



4F026XJ02

There is therefore an increase in the passage sections and consequently a slowing down in the flow of exhaust gases which pass through the turbine (1) at the same speed or slower than the low speed conditions.

The speed of the turbine (1) decreases and settles down at a suitable value for the correct operation of the engine at high speeds.

1. Turbine
2. Moving vanes
3. Pneumatic actuator
4. Rotary seal

*TURBOCHARGER (1910 JTD 100 CV)

It basically consists of two impellers (1) on one shaft (2) which rotates on floating bearings lubricated by a duct (3) from the engine lubrication circuit.

The oil used dissipates some of the large amount of heat given off by the exhaust gases at the turbine.

There is a waste gate valve (4) fitted on the turbocharger, operated by a pneumatic actuator (5), that makes it possible to shutter the flow of exhaust gases to the turbine, according to the engine power/torque requirements.

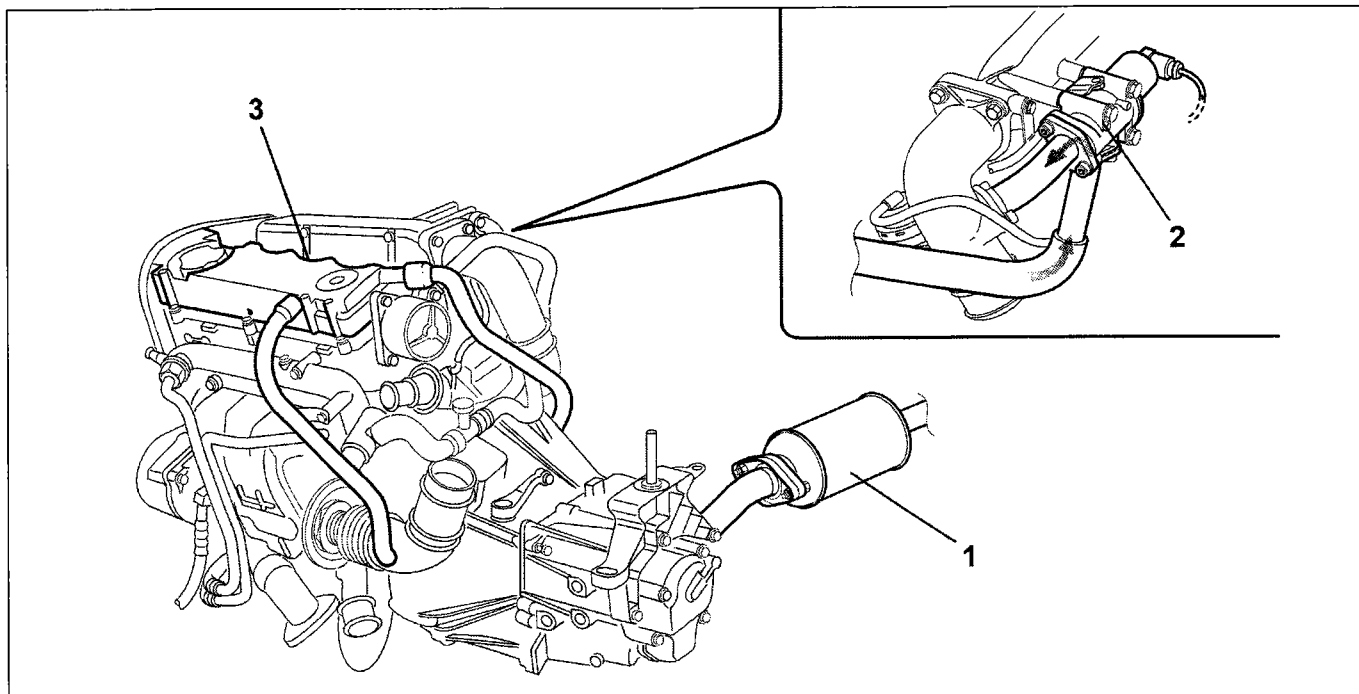
The pneumatic actuator is controlled by the engine management control unit via a solenoid valve.

* The turbocharger used on the 1910 JTD 100 CV version is the fixed geometry type.

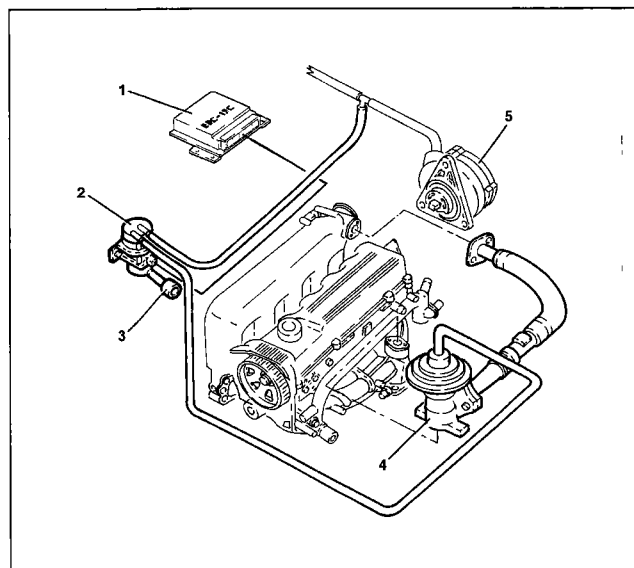
EMISSION CONTROL DEVICES

The car is equipped with devices designed to reduce polluting emissions in accordance with Euro 3 requirements:

- Oxidising catalytic converter (1)
- Exhaust gas recirculation circuit (EGR) (2)
- Crankcase blow-by vapour recirculation circuit (3).



4F027XJ01



4F027XJ02

OXIDISING CATALYTIC CONVERTER

The oxidising catalytic converter is a post-treatment device used to oxidise CO, HC and particulate and convert them to carbon dioxide (CO₂) and water vapour (H₂O).

The catalytic converter consists of a ceramic honeycomb case (1) with its chambers impregnated with platinum, a substance that catalyses oxidation reactions.

Exhaust gases flow through the chambers and heat the catalytic converter where they trigger the conversion of pollutants to inert compounds.

The chemical reaction involved in oxidising the CO, HC and particulate is effective at temperatures between 200 °C and 350 °C.

Above 350 °C, the sulphur in the diesel begins to oxidise to produce sulphur dioxide and sulphuric acid.

EXHAUST GAS RECIRCULATION CIRCUIT (EGR)

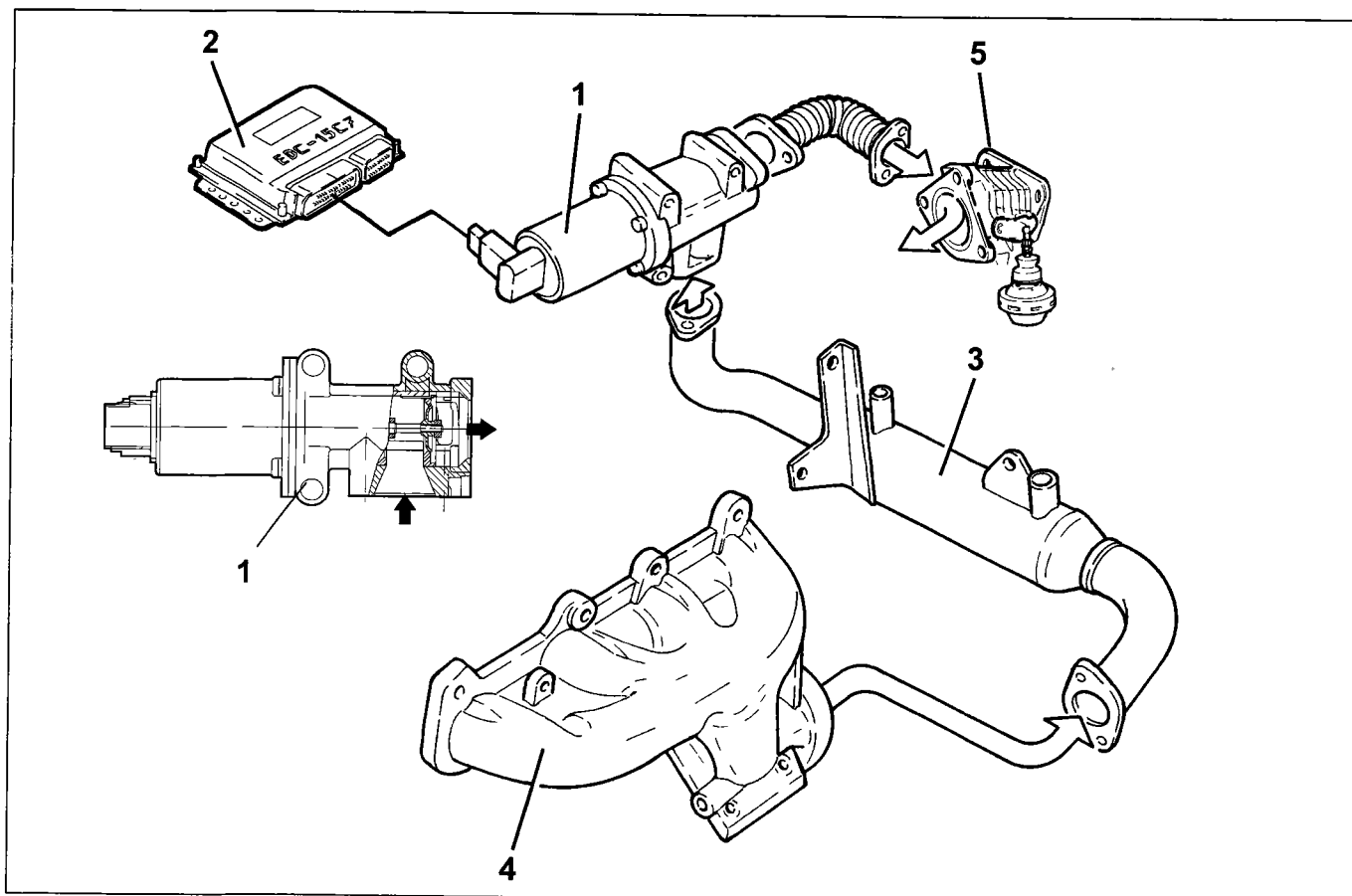
This system sends a proportion of exhaust gases to the intake under certain engine service conditions. This dilutes the fuel mixture with inert gases to lower peak temperature in the combustion chamber; This helps limit the formation of nitrogen oxides (NO_x) and reduces exhaust levels by 30-50%.



10.

The EGR valve consists of:

- a Pierburg EGR solenoid (1) operated by engine management unit (2)
- a pipe from the exhaust manifold (4) (from which the exhaust gases flow)
- an air-water heat exchanger (3) (that lowers exhaust gas temperature)
- a pipe connected to throttle body (5) to which exhaust gases are admitted



4F028XJ01

Operation

With coolant temperature $> 20^{\circ}\text{C}$ and engine speeds between 800 and 3000 rpm, the engine management unit controls the EGR solenoid by means of a square wave signal.

Changes in this signal allow the EGR coil to move a plunger and thus modulate the flow of exhaust gas from the exhaust manifold to the intake manifold; this achieves two results:

- less air is taken in
- combustion temperature is lowered (due to the presence of inert gases), thus reducing the formation of NO_x (nitrogen oxides).

The engine management control unit is constantly informed of recirculation gas quantity via data from the debimeter. If the intake of a given quantity of air (Q_{am}) is required for a given rpm and the level sent by the debimeter (Q_{ar}) is lower, the difference (Q_{gr}) is the amount of gas recirculated.

$$Q_{am} - Q_{ar} = Q_{gr}$$

Q_{am} = stored theoretical air quantity

Q_{ar} = actual air quantity

Q_{gr} = recirculated gas quantity

An atmospheric pressure signal is used in controlling the EGR valve to detect when the car is being driven at altitude. The recirculation gas quantity can then be reduced to prevent engine fumes.

10.

RECIRCULATION CIRCUIT FOR CRANK-CASE VAPOURS (BLOW-BY)

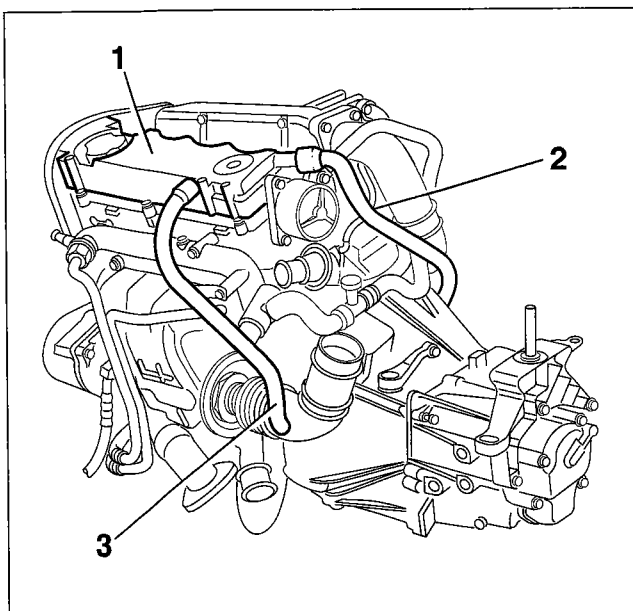
The control of the oil vapour emissions is achieved through a separator (1) (function carried out by the tappet cover) which collects the vapours released by the crankcase in the pipe (2).

The difference in temperature between the separator and the oil vapours causes partial condensation.

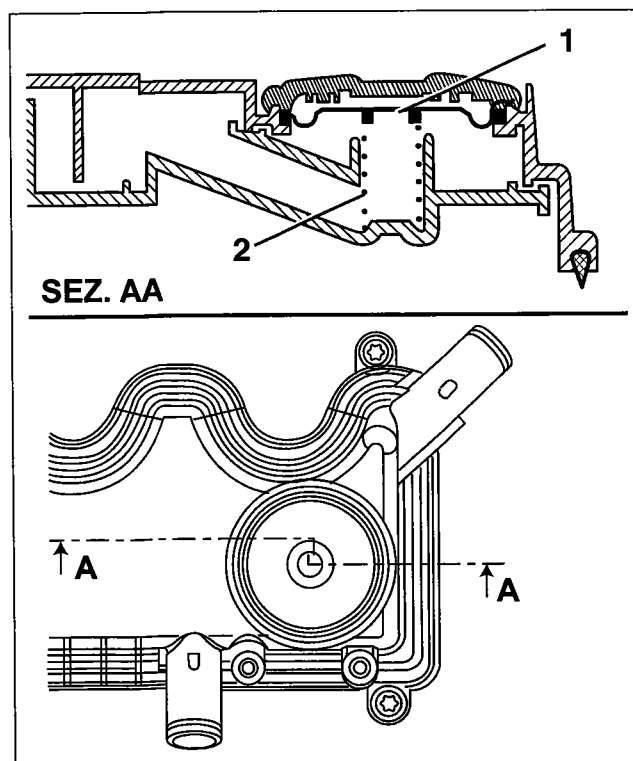
The vapours which have not condensed are sent, via the pipe (3), to the turbocharger air intake hose.

The adjustment valve, consisting of a spring (1) and a diaphragm (2), on the tappet cover makes it possible to prevent intake.

When the vacuum values inside the tappet cover exceed a pre-set limit, the diaphragm moves downwards sealing the duct from the crankcase.

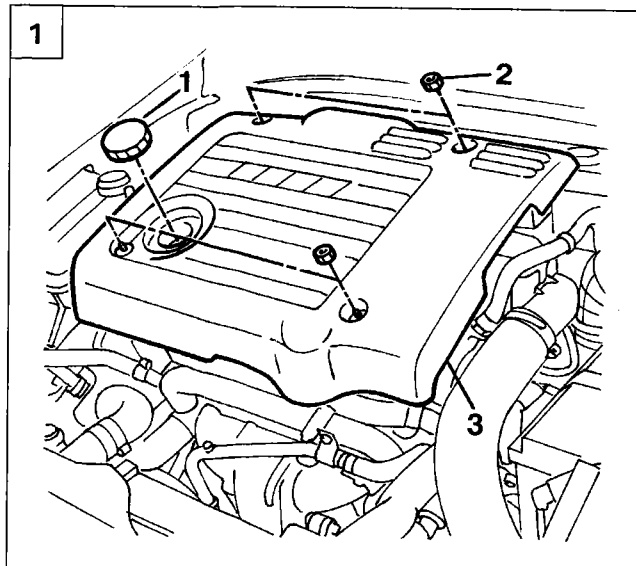


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4F029XJ02

10.



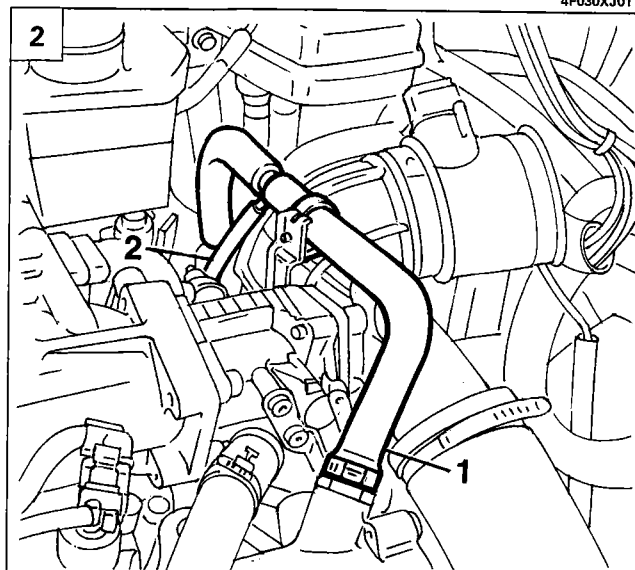
THROTTLE CASING



Removing-refitting

- Remove the battery from the engine compartment, then proceed as described below;

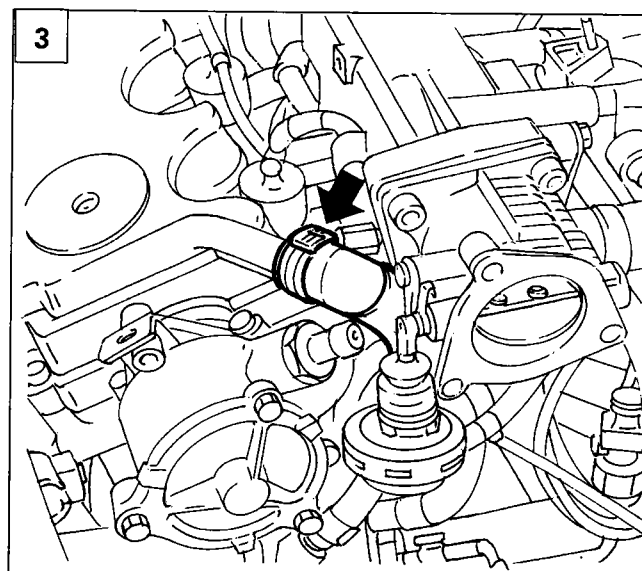
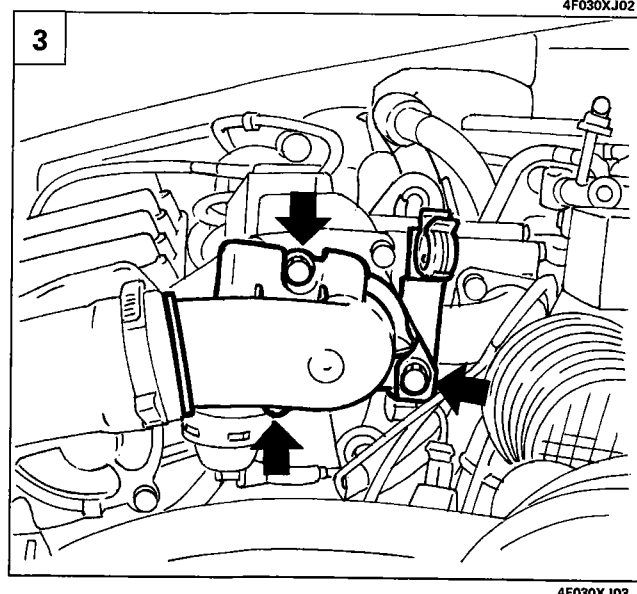
1. Remove the engine oil filler cap (1), then undo the fixing nuts (2) and remove the sound insulation cover (3).

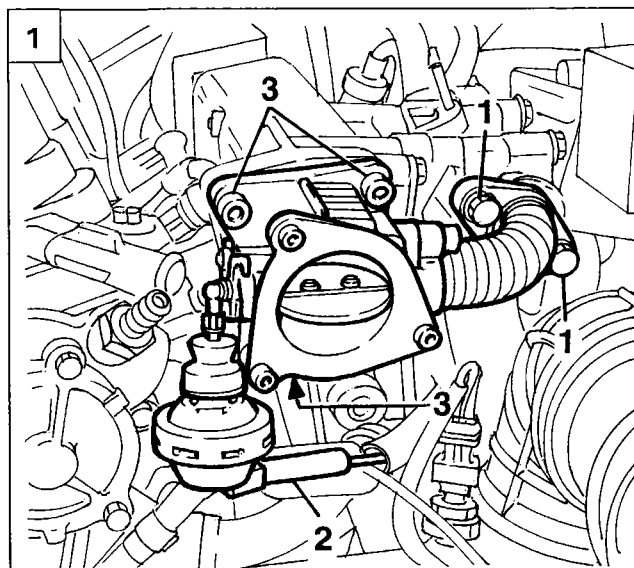


2. Disconnect the vacuum intake pipe (1) from the vacuum unit acting on the retaining band. Also disconnect the pipe (2) connected to the vacuum reservoir.

3. Undo the bolts fixing the connector pipe between the throttle casing and the hose connected to the intercooler.

4. Disconnect the oil vapour recovery pipe from the tappet cover, acting on the retaining band.

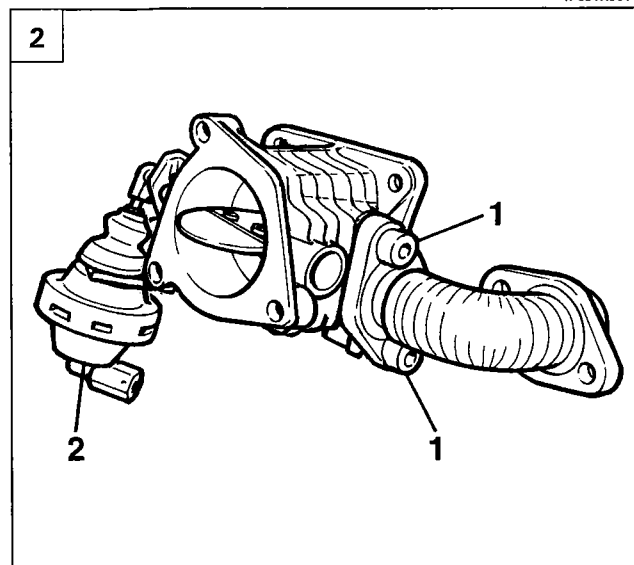




1. Undo the bolts (1) fixing the expansion joint to the E.G.R. valve, disconnect the pipe connecting the pneumatic valve and the solenoid valve, then undo the bolts (3) and remove the throttle casing.

2. At the bench, undo the bolts (1) and separate the expansion joint from the throttle casing.

The pneumatic valve (2) is secured to the throttle casing.



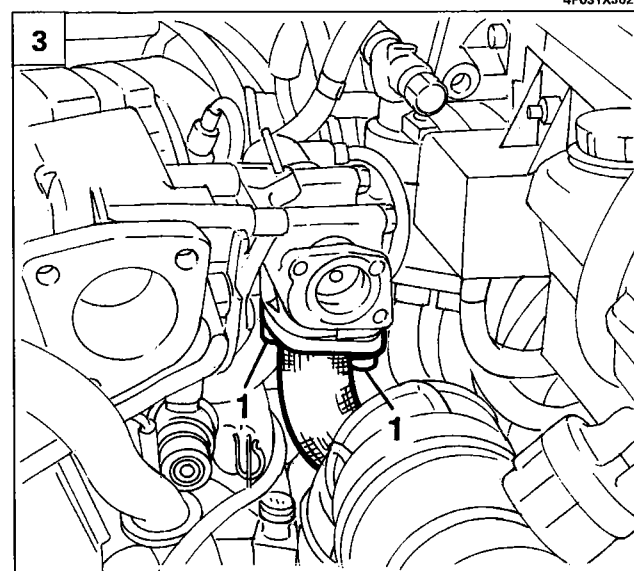
E.G.R. VALVE

Removing-refitting

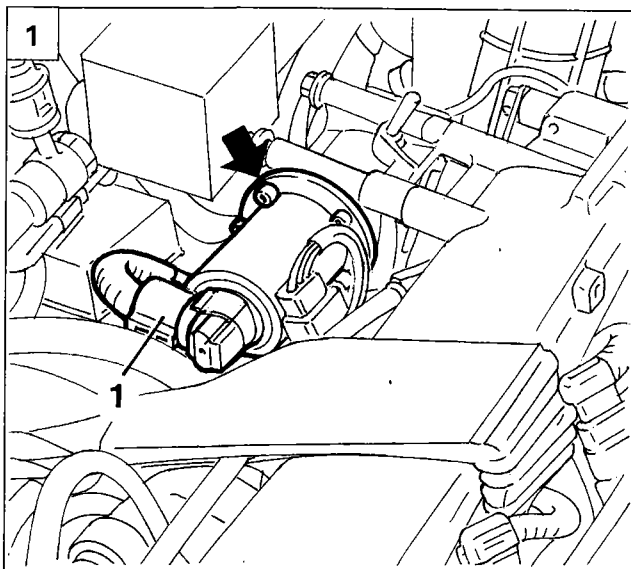
- Remove the throttle casing, following the description in the previous paragraph.

3. Loosen the bolts (1) fixing the pipe connecting the E.G.R. and the heat exchanger.

4. Disconnect the electrical connection (1) for the E.G.R. valve self-adjustment motor; undo the bolts (2) fixing the E.G.R. valve to the intake manifold, then lift up the valve and remove the bolts fixing the pipe connected to the heat exchanger (loosened previously).



10.



E.G.R. VALVE SELF-ADJUSTMENT MOTOR

Removing-refitting

- Disconnect the negative battery lead, then remove the sound insulation shield following the instructions in the previous paragraphs.

1. Disconnect the electrical connection (1), then loosen the bolts fixing the E.G.R. valve self-adjustment motor and remove it.

E.G.R. VALVE HEAT EXCHANGER

Removing-refitting

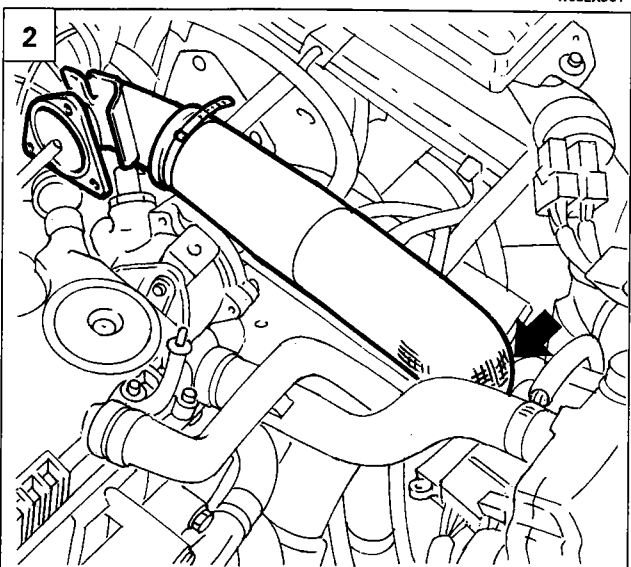
- Remove the throttle casing and the E.G.R. valve following the instructions in the previous paragraphs.

2. Remove the hose connecting the throttle casing to the intercooler.

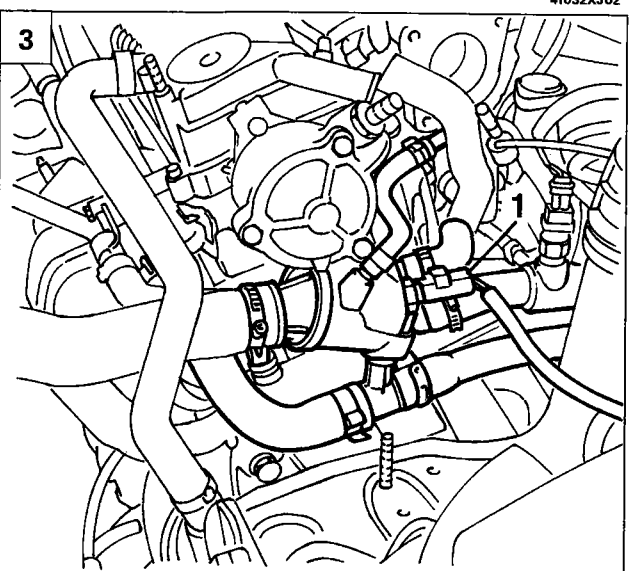
- Drain the engine coolant.

3. Disconnect the pipes shown in the figure from the thermostat, acting on the retaining bands, then disconnect the electrical connection (1) for the engine coolant temperature sensor.

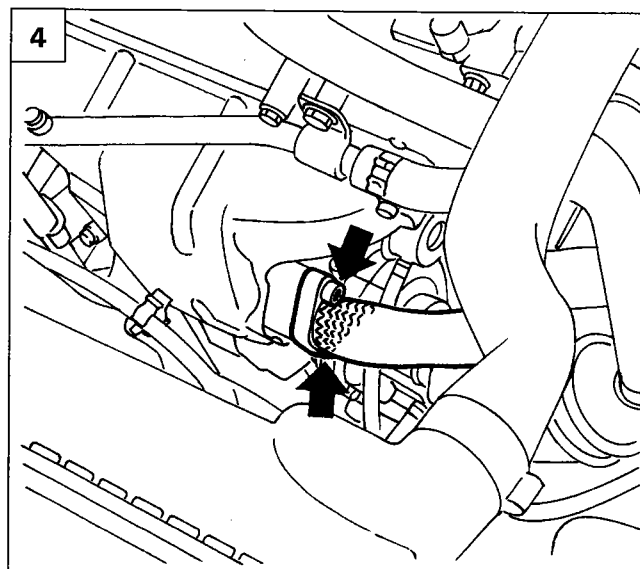
4. Undo the bolts fixing the heat exchanger pipe to the exhaust manifold.



4f032XJ01

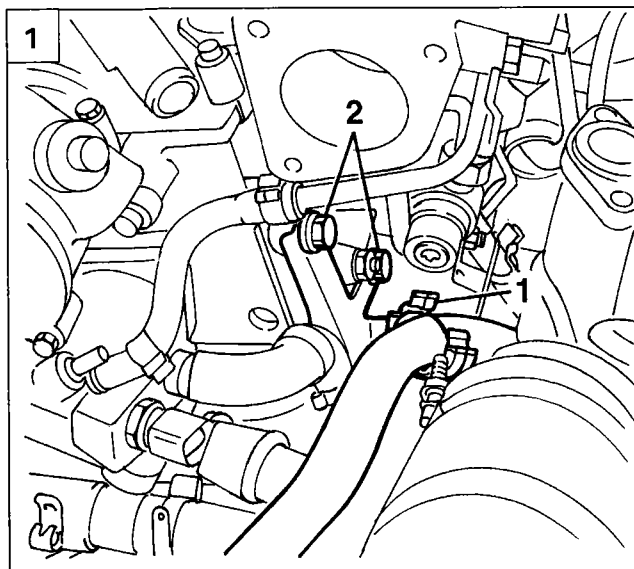


4f032XJ02

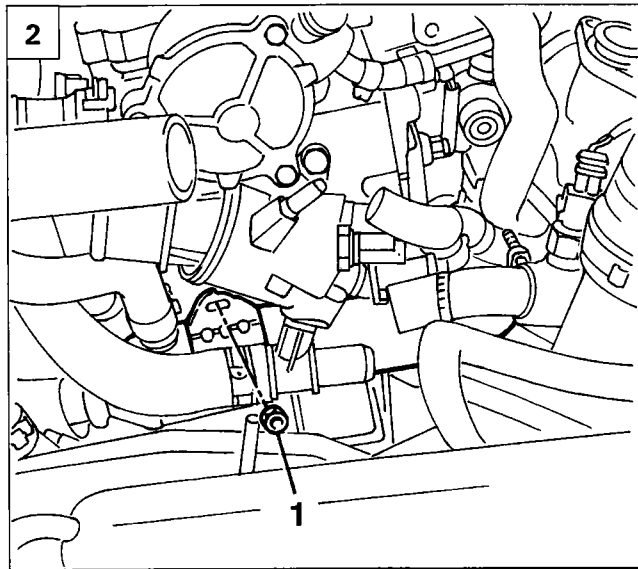


4f032XJ04

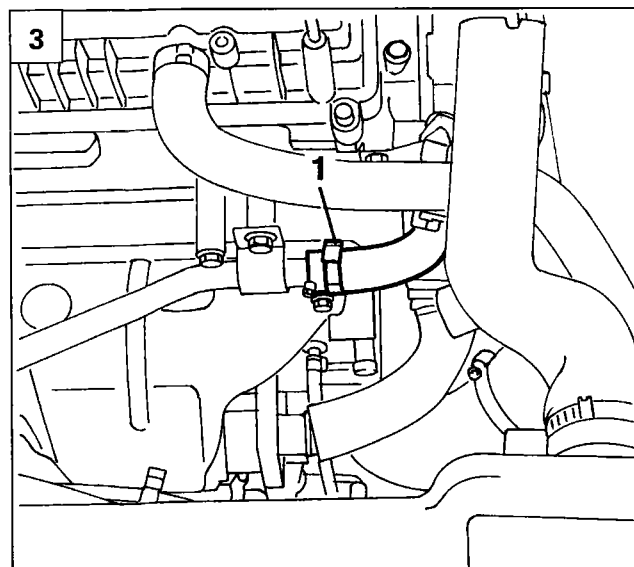
10.



4F033XJ01



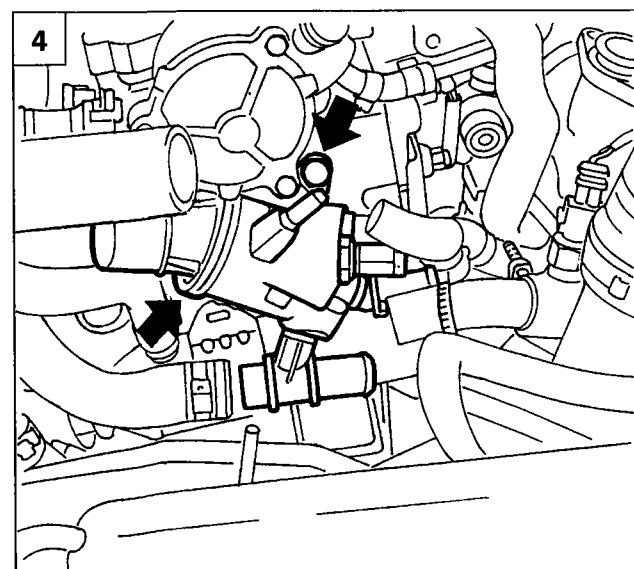
4F033XJ02



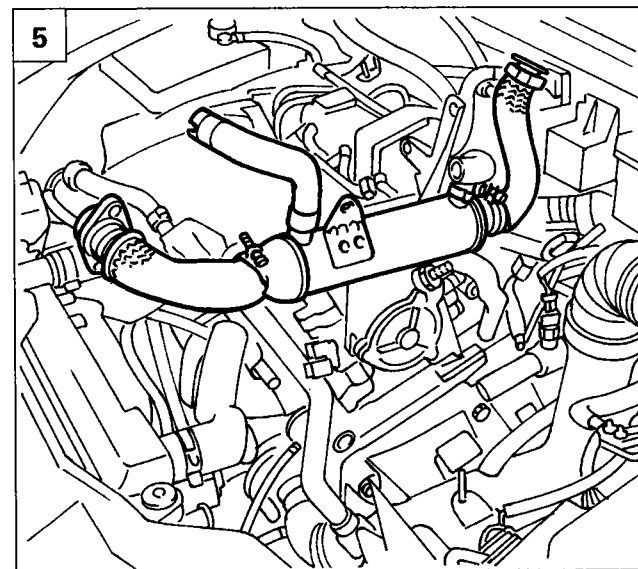
4F033XJ03



1. Open the band (1) retaining the oil vapour recovery pipe, then undo the bolts (2) fixing the E.G.R. valve heat exchanger mounting bracket.
2. Undo the nut (1), located under the thermostat, fixing the heat exchanger.
3. Disconnect the band (1) retaining the coolant pipe for the heat exchanger.
4. Undo the bolts shown in the diagram and remove the thermostat to allow the subsequent extraction of the heat exchanger.
5. Remove the heat exchanger from the engine compartment.

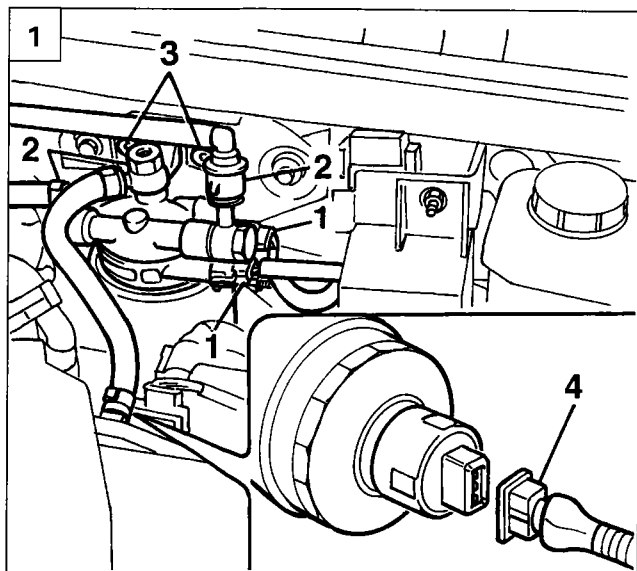


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4F033XJ05

10.



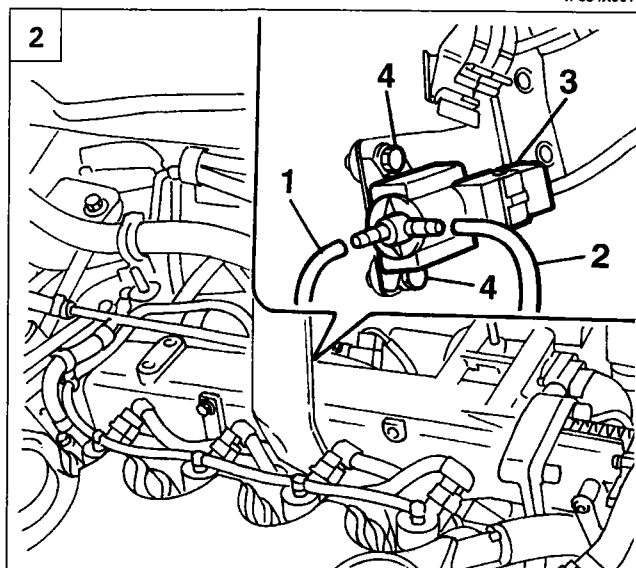
4F034XJ01



SOLENOID VALVE ON VACUUM RESERVOIR FOR THROTTLE CASING PNEUMATIC VALVE

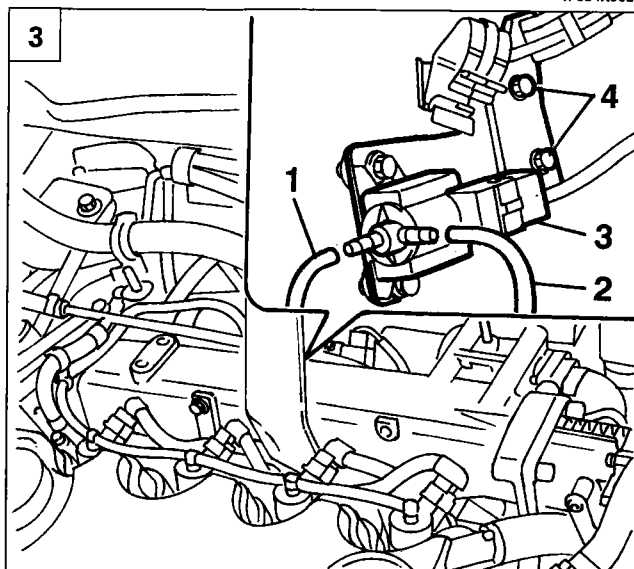
Removing-refitting

- Disconnect the negative battery lead, then remove the sound insulation shield following the instructions in the previous paragraphs.
- 1. Disconnect the electrical connections (1) at the fuel filter and the supply and return pipes (2) at the reservoir and the supply pipe to the pump, then loosen the nuts (3) fixing the fuel filter mounting. Lift up the filter and disconnect the electrical connection (4) for the water in the diesel sensor.



4F034XJ02

- Release the power assisted steering fluid supply pipe from the reservoir to the pump from the retaining band.
- 2. Disconnect the pipe (1) connected to the vacuum reservoir and the pipe (2) connected to the vacuum intake pipe from the solenoid valve. Disconnect the electrical connector (3), then undo the fixing bolts (4) and remove the solenoid valve.

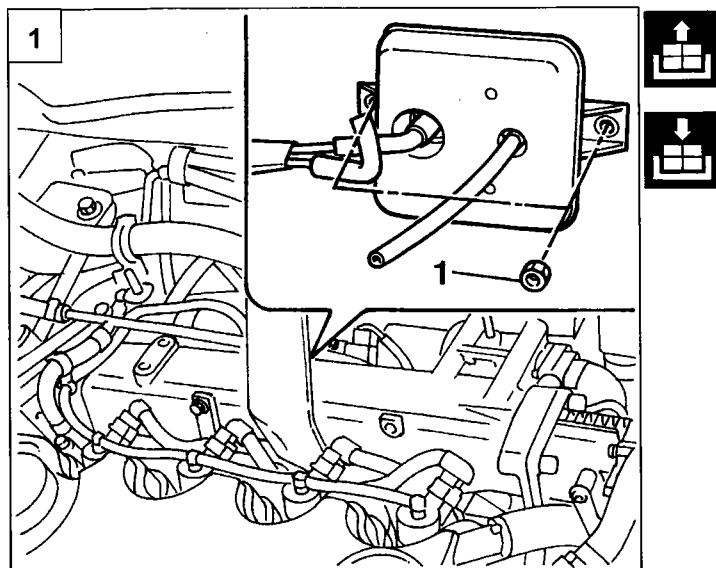


4F034XJ03

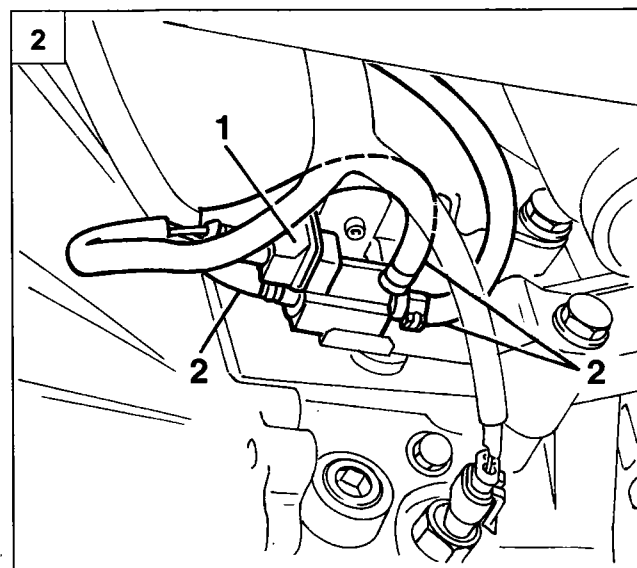
VACUUM RESERVOIR

Removing-refitting

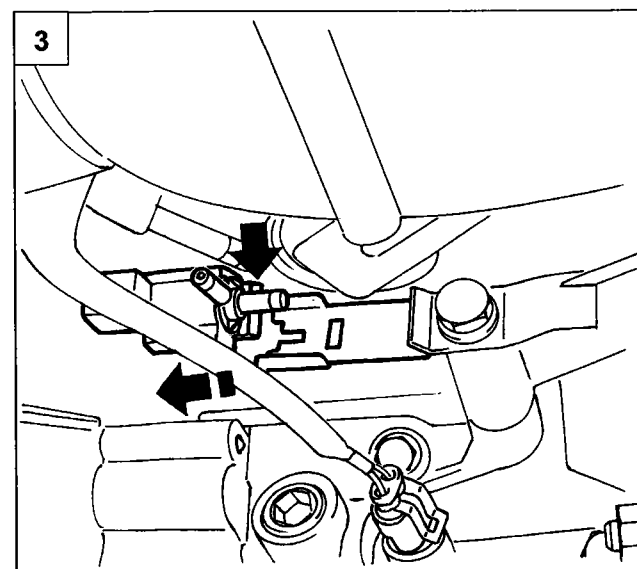
- Disconnect the negative battery lead, then remove the sound insulation shield and the fuel filter, following the instructions in the previous paragraphs.
- Release the power assisted steering fluid supply pipe from the reservoir to the pump from the retaining band.
- 3. Disconnect the pipe (1) connected to the vacuum reservoir and the pipe (2) connected to the vacuum intake pipe from the solenoid valve. Disconnect the electrical connector (3), then undo the fixing bolts (4) and remove the bracket, complete with solenoid valve, for the throttle casing pneumatic valve.



4f035XJ01



4f035XJ02



4f035XJ03

1. Undo the fixing nuts (1) and remove the vacuum reservoir.

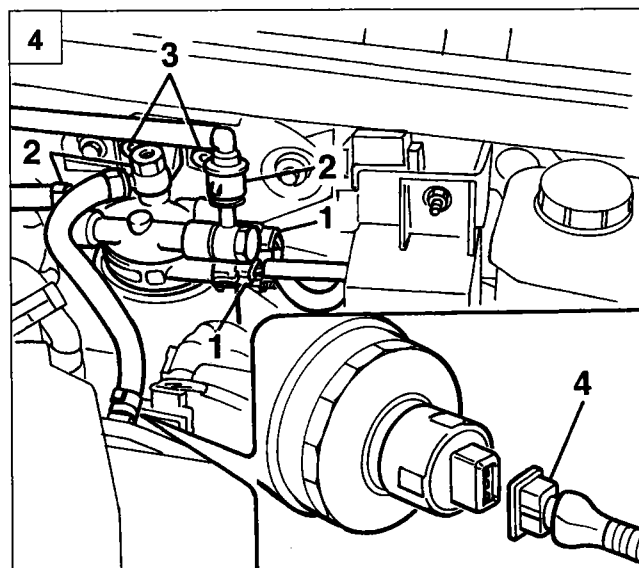
SOLENOID VALVE CONTROLLING SUPERCHARGING PRESSURE Removing-refitting

- Position the vehicle on a lift, then disconnect the negative battery lead.
2. Working from underneath the vehicle, disconnect the electrical connector (1) and the pipes (2).
 3. Press the retaining tab on the rear of the mounting bracket and release the solenoid valve.

FUEL FILTER

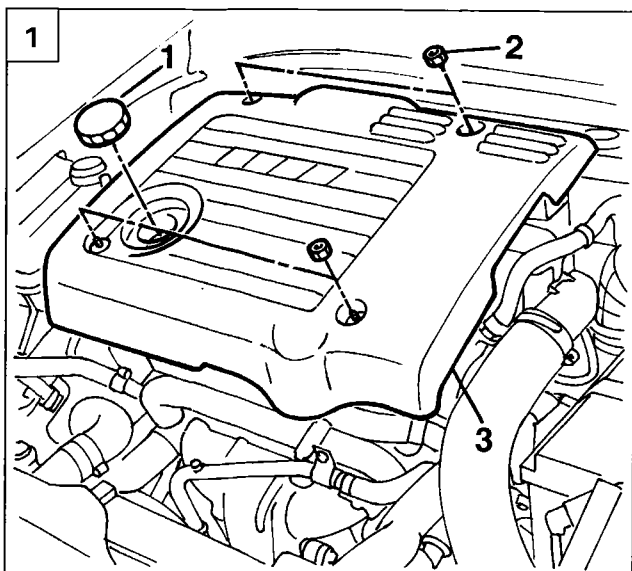
Removing-refitting

4. Disconnect the electrical connections (1) from the fuel filter and the supply and return pipes to the tank and the supply pipes to the pump (2), then undo the nuts (3) fixing the fuel filter mounting. Lift up the filter and disconnect the electrical connection (4) for the water in the diesel sensor.



4f035XJ04

10.



PRESSURE REGULATOR

NOTE During the operations of removing-refitting the pressure regulator, work in extremely clean conditions.

Removing

- If the vehicle is equipped with a shield under the engine, remove it.

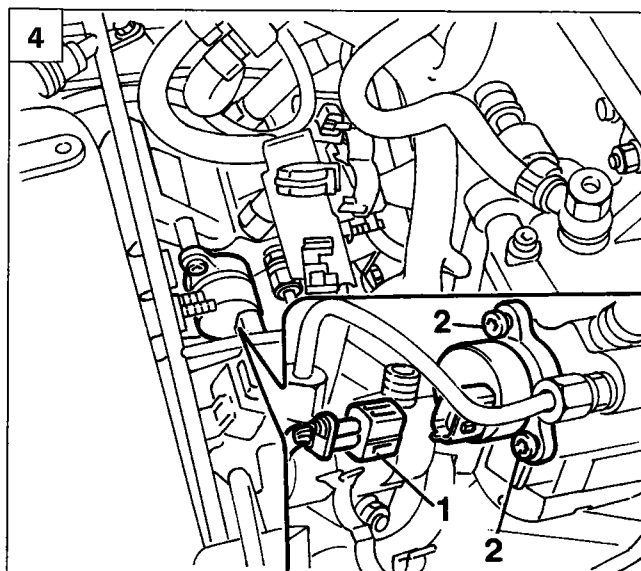
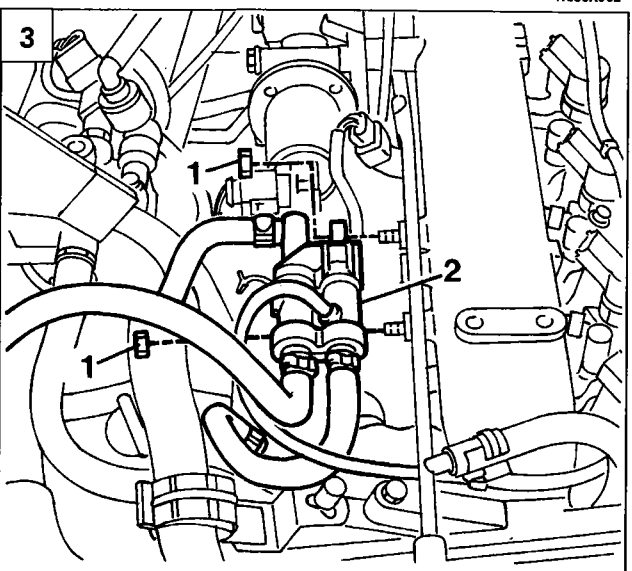
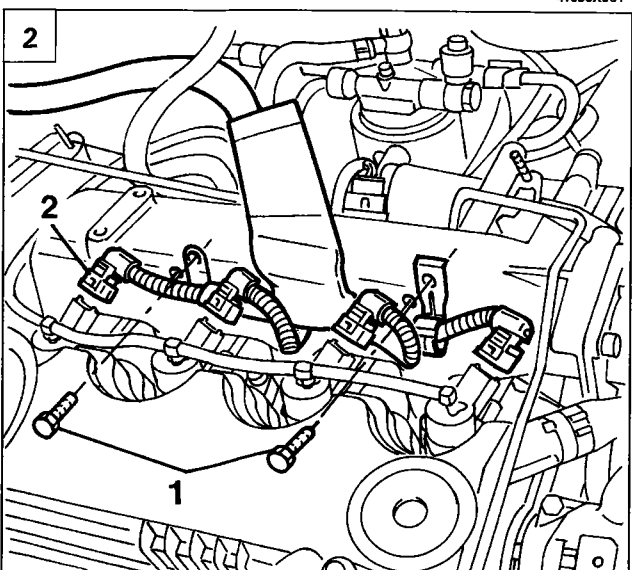
1. Remove the engine oil filler plug (1), then undo the fixing nuts (2) and remove the sound insulation cover (3).

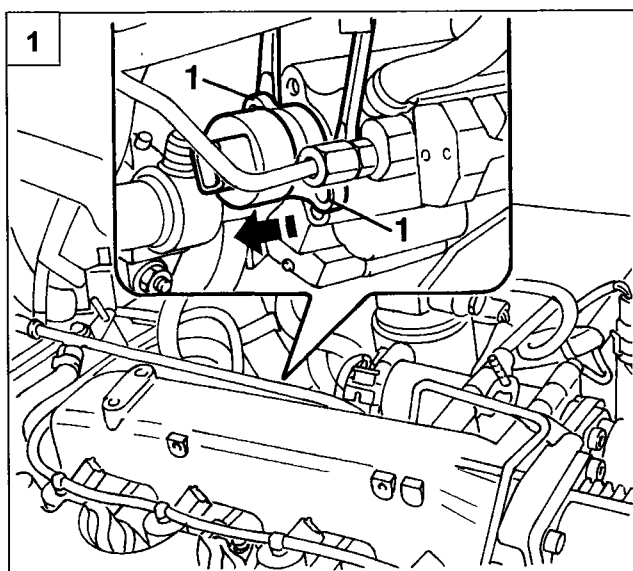
2. Undo the bolts (1) fixing the retaining bands for the injector wiring. Disconnect the electrical connectors (2) for the injectors and place the wiring to the side.

- Release the injection cable loom from the retaining bands.

3. Undo the nuts (1) fixing the fuel return manifold pipe (2) to the intake manifold. Place the fuel return manifold pipe to the side.

4. Disconnect the electrical connector (1) for the pressure regulator, then undo the bolts (2) fixing the regulator to the pump.





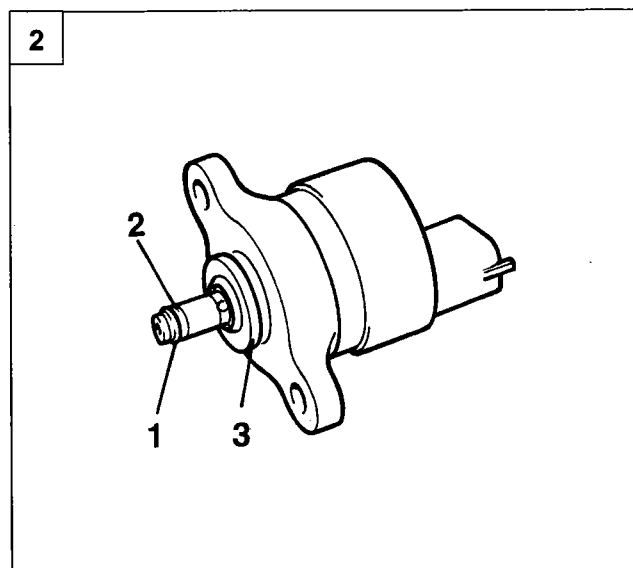
4f037XJ01

1. Grip the outer casing of the regulator, partly extract it and, at the same time, rotate it so that the fins (1) which contain the openings for the fixing bolts are positioned horizontally.

NOTA Do not grip the pressure regulator by the electrical connector.

Insert the blades of two screwdrivers by the fins (1) and very carefully extract the pressure regulator.

NOTE Do not use a screwdriver or other tools in the seal areas between the regulator and the pressure pump.



4f037XJ02

2. Pressure regulator

1. High pressure seal (black or green)
2. Anti-extrusion seal (white)
3. Low pressure seal (black)

NOTE If the high pressure seal accidentally remains inside the pump casing, turn the ignition key to the ON position (engine switched off); this will operate the pump shaft and a small amount of fuel and the seal will come out.

NOTE Do not, under any circumstances, use any tools for extracting the high pressure seal and this could damage the inner surface of the pump.

Refitting

- Suction off any impurities present inside the pump casing.
- Check the condition of the three seals and make sure they are correctly positioned before fitting.
- Slightly lubricate the outer surface of the three seals using vaseline. Do not, under any circumstances, lubricate the other surfaces of the pressure regulator.
- Insert the pressure regulator in its housing on the pump, pressing gently and, at the same time, rotating the regulator until it is in contact with the surface of the pump.

NOTE Do not, under any circumstances, use a hammer or other tools when fitting the pressure regulator.

- Fit the two bolts fixing the pressure regulator to the pump casing, and tighten them to a torque of 0.9 ± 0.1 daNm.
- Reconnect the electrical connector and complete the refitting of the remaining components reversing the order of the operations carried out for the removal.

